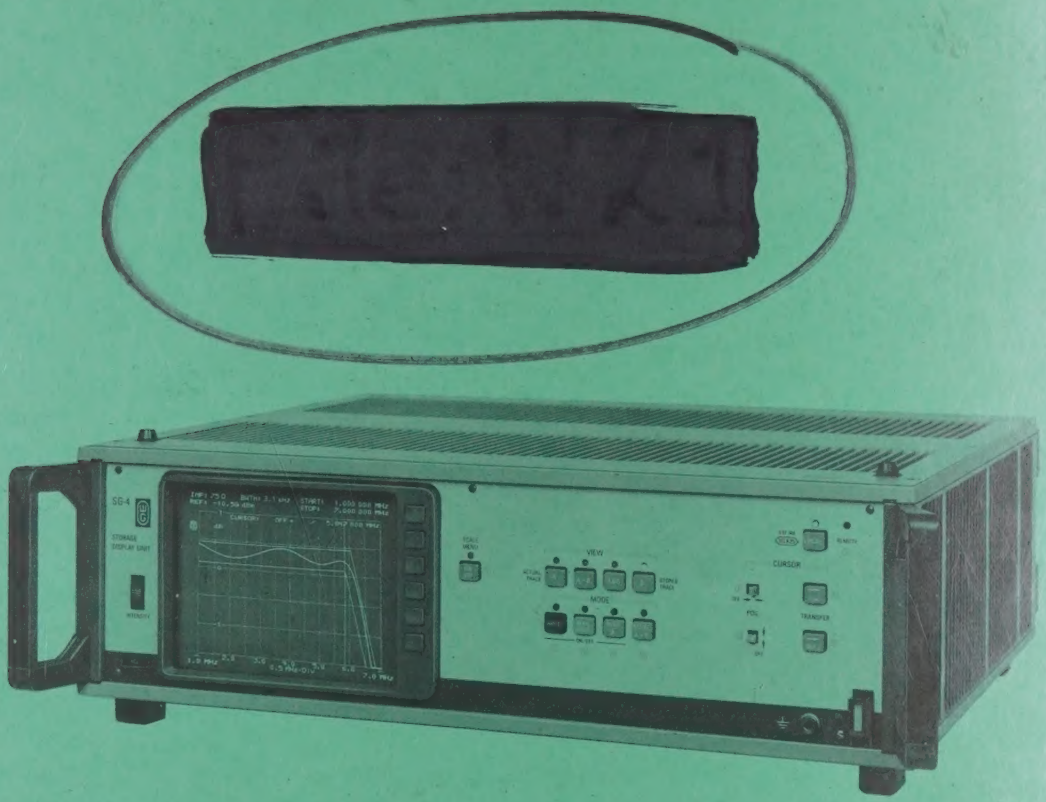
Description and Operating Manual



Display Unit

SG-4

with digital image storage for use with the SPM-16 and SPM-19 Selective Level Meters

BN 0957/00.82; Series A...

SUPPLEMENT TO DESCRIPTION AND OPERATING MANUAL SG-4, Series A..., BN 957/01

CHAPTER 3.10: COMPUTER CONTROL, <IEC 625>-/IEEE 488-BUS

3.10.1 GENERAL, page 3-31

If the address switch on the back panel of the Display Unit is changed during the IEC/IEEE Bus operation, then the SG-4 must be switched off and then on again, so that the computer recognizes the new setting.

3.10.2.2 Interrupt program, Fig. 3-21 (page 3-33)

When a computer from a manufacturer other than Hewlett Packard is used (e.g. Commodore), it is possible that as a result of exceeding the time limits, the handshake cycle might not be maintened any longer.
The computer stops the transmission and sets the status word (ST). For that reason, "Time-Out" should be switched off when the handshake cycle is operating. For instance, the Commodore 8032 is instructed by "POKE 1Ø2Ø, 128".

3.10.2.3 Status Information, page 3-34

In positions Ø and 1 the status bits are always set to be zero.

3.10.4.1 Interrupt program for HP-85, page 3-36, 3-37

When translating the HP-85 program to the HP 9836, the statement 540 (corresponding position in HP-85 program) should be inserted by means of the following instruction: 540 ENABLE INTR 7, (HP 9836 command).

3.10.4.5 B curve plotting (G), page 3-42

Statement 42Ø should be: OUTPUT 7ØØ; "T1, BØ, KØ, S,"

3.10.4.6 Data output (D), page 3-44

Statement 3ØØ DIM C$ [4ØØ], 400 characters attain: 100 times $\sqcup\sqcup\sqcup\bullet\sqcup$ ($y^2\ y^1\ y^0$)

3.10.5 PROGRAMMING WORDS

- INTERFACE MODE, page 3-45

  The character ⓪ can also be selected instead of XX

- DATA TRANSFER SPM→SG-4 (I); page 3-45

  The "I" command is necessary after any new setting-up of the Level Meter, so that the relevant parameters are transferred to the Display Unit. But, the "I" command is not necessary in the example given in section 3.10.4, where the Level Meter is to be set-up once to begin a program run-off (before the execution of the first SG-4 statement).

- SOFTKEY DISPLAY (K), page 3-47

  Ø and 1 should be substituted for one another (change places)

- GRAPHICS PLOTTER OPERATION/SUPERPOSITION and BLANKING of the INTERNAL GRATICULE (P), page 3-49

  The programming word "P␣," has two main functions:

  1. SUPERPOSITION/BLANKING OF INTERNAL GRATICULE (no plotter function!); see section 3.8.3

     "PØ," measurement curve display without graticule

     "P1," measurement curve display with graticule (after the graticule has been switched off with PØ, the graticule can be again superimposed with P1)

  2. GRAPHICS PLOTTER OPERATION; see section 3.9.2

     "P2," start graphics plotter (measurement curve display without graticule)

     "P3," start graphics plotter (measurement curve display with graticule)

- DATA OUTPUT (D), page 3-49

  In order that all 511 curve points can be read-out, the following programming word can be used (Y_{max} values of curve A):

  "DAMAXALL," (equivalent to "DAMAXØØØ51Ø,")

  In a similar manner, the programming word can be formed for the Y_{min} values and for the B curve.

SG-4, Series C ...

Paragraph 1.2.3 Division of the graticule scale

in 1 dB range..... 12 Div., (0.2 dB/Div.)

DISPLAY UNIT SG-4

with digital image storage for use with
the SPM-16 and SPM-19 Selective Level Meters

Description and Operating Manual BN 957/01, Series A...

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PRECISION ELECTRONIC
MEASURING INSTRUMENTS

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INTRODUCTION

With the aid of the SG-4 Display Unit, the Selective Level Meters SPM-16 and SPM-19 can be converted to panoramic receivers or, if a suitable level generator is available, to a sweep measuring setup. The Display Unit produces a stationary, flicker-free picture even at slow sweep rates. It is thus particularly suitable for measurements on test items with long settling times and for display of spectral lines or system loading of FDM systems.

The Display Unit is equipped with two digital trace stores, which permit display of a stored reference trace in addition to the actual measured trace.

The two trace stores, each with an X-Y resolution of 511 x 256 pixels, permit, amongst other things, the display of a level difference with which a higher measuring and alignment accuracy can be achieved. If the intrinsic frequency response of the setup is recorded and stored with the generator and receiver connected back-to-back, the intrinsic error of the setup can be virtually eliminated in differential mode. If the reference store contains the nominal trace of a test item, then optimum alignment of the connected item can be carried out. The displayed measured trace is updated immediately whenever the level changes. Precise reading of signals with superimposed noise is possible by means of the noise averaging facility, and it is not necessary to sweep at a lower rate.

The SG-4 is equipped with a large flat screen whose electronically generated and calibrated internal graticule permits the measured values to be read from a level-linear scale in dB, dBm, or dBm0 without parallax errors. Important receiver parameters are also displayed on the screen. The level and frequency can be read accurately from the screen using the line cursor provided for each parameter, whose absolute values are displayed with a maximum resolution of 0.01 dB and 0.1 Hz respectively. When acting as a controller, the Display Unit can pass on both values to the Level Meter where they can be used as the new reference level or center frequency. This permits the most interesting part of the trace to be selected. The trace can be frozen for subsequent evaluation.

Two independent tolerance limits, which can consist of several straight lines with any required angle, can be displayed and stored in order to check whether the level of a trace lies within specific limits. If required, further tolerance masks can be stored in the SG-4 with the "MEMORY" key of the Level Meter.

The Display Unit SG-4 has a video output to which a video plotter can be connected for generation of a hard copy of the complete screen information.

A monitor can also be connected to this output for enlarged display of the screen contents or for display at a remote location. A graphic plotter (e.g. HP 7470 A) can also be connected.

The SG-4 is a compact unit, only 3 height units high, and is connected via 2 included cables to the Selective Level Meter SPM-16 or SPM-19. For this purpose, the Level Meter must be equipped with the standardized interface bus board (IEC/IEEE). If a desk top computer is added, the result is an easy-to-use automatic measuring system.

1 TECHNICAL DATA

The SG-4 is a special Display Unit for the Selective Level Meters SPM-16 and SPM-19.

1.1 TRACE STORAGE

The SG-4 operates with 2 digital trace memories

Trace A..... is rewritten with each out and return deflection of the sweep voltage[1)]

Trace B..... remains stored as a complete trace[2)]

Resolution

X direction..... 511 pixels

Y direction..... 256 pixels

1.2 SCREEN DISPLAY

1.2.1 TRACE DISPLAY

Display of measured trace "A"

and reference trace "B"..... single: "A" or "B"

or..... together: "A & B"

or..... as difference: "A - B"

Instantaneous value of measured trace

marked by..... record marker[3)]

1.2.2 CURSOR DISPLAY

Frequency cursor (vertical line)

Resolution..... 511 pixels

Level cursor (horizontal line)

Resolution..... 256 pixels

Corresponding frequency and level values are displayed alphanumerically with a resolution

in X direction..... frequency sweep/511

in Y direction..... 0.01, 0.1, or 0.33 dB[4)]

---

1) With sweep, autostep or track, and manual tuning of the SPM-16/19.

2) Can be transferred to memory A if required (or read in via IEC Bus).

3) Visible at sweep times $\geq$ seconds.

4) Depending on selected measuring range: 1, 20, or 80 dB scale.

1.2.3 BACKGROUND DISPLAY

Calibrated internal graticule

With smoothed graticule marked with frequency and level values

Scale (Div.) in Y direction

in 80 dB range..... 8 Div., (10 dB/Div)
in 20 dB range..... 5 Div., (5 dB/Div)
in 1 dB range ..... 5 Div., (0.5 dB/Div)

Scale (Div.) in X direction.....variable, depending on frequency range

Minimum scale..... 10 Div.
Maximum scale..... 18 Div.

Text display

The relevant receiver parameters are displayed above the graticule.

1.2.4 CATHODE

Type ..... 7 inch flat screen
Intensity..... adjustable

1.3 RESOLUTION AND MEASURING ERRORS

Measuring range on SPM-16 or SPM-19	80 dB range	20 dB range	1 dB range
Display range (dynamic)[1]	85 dB	25 dB	2.5 dB
Resolution of SG-4	0.33 dB	0.1 dB	0.01 dB
SG-4 errors	±0.8 dB	±0.2 dB[2] ±0.5 dB[3]	±0.03 dB
The overall error of the SG-4 and Level Meter is equal to the error specified for the analog display of the Level Meter SPM-16 or SPM-19.			

1) Linear dB scale
2) In the range -5 to +2 dB
3) In the range -10 to +2 dB

1.4 DISPLAY UNIT INPUT

14-pole socket for cable K 145 from SPM-16 or SPM-19

1.4.1 X INPUT

Input voltage range..... ±2.5 V ±5%
Maximum input voltage..... ±15 V
Fastest sweep rate..... 100 ms/frame
Calibration..... automatic upon switching on

1.4.2 Y INPUT

Input voltage range..... approx. 0 to 5 V
Maximum input voltage..... ±15 V
Fastest change..... 0.6 ms/frame

1.5 ADDITIONAL FUNCTIONS

Noise averaging

Cyclic averaging of sequential sweep traces in order to suppress random interference components (e.g. noise).

Maximum hold

Display of the maximum signal level which occurs within the selected display column.

Tolerance masks

Two strings of line segments with any required positions of the corners can be displayed and stored with the aid of the cursor. A memory for additional masks is fitted.

Controller function

The cursor values for level and frequency can be transferred to the level meter for use as a new reference level and new center frequency.

1.6 ADDITIONAL INPUTS AND OUTPUTS

1.6.1 IEC (IEEE) BUS CONNECTION

For connection to the SPM-16 or SPM-19 or for parallel connection of a computer and (or) graphic plotter.

1.6.2 VIDEO OUTPUT

For external monitor or video plotter
Peak value of voltage when terminated with 75 Ω..... 1 V_{pp}
Frame frequency..... 50 Hz[1)]
Line frequency..... 15.625 kHz[1)]

1.7 GENERAL DATA

1.7.1 PERMISSIBLE AMBIENT TEMPERATURE

Rated range of use..... +5 to +40 °C
Storage and transport..... -40 to +70 °C

1.7.2 POWER SUPPLIES

Rated range of use of mains voltage.....110/117/127/220/227/237 V, in all cases -12 to +10%
Rated range of use of mains frequency..... 47.5 to 63 Hz
Power consumption .....approx. 70 VA
Protection class in accordance with IEC 348 and VDE 0411..... Class I

1.7.3 DATA RETENTION

A built-in, trickle-charged battery maintains the memory contents for the instrument setup, the reference curve, and the tolerance masks in the case of a power failure.

1.7.4 DIMENSIONS

in mm

Bench model		19" chassis (DIN 41 494)	
Width with handles	477	Chassis width	443
Overall height	155	Chassis height (3 units)	131
Depth with handles	434	Chassis depth	379

1.7.5 WEIGHT..... approx. 12 kg

1.8 ACCESSORIES

Included:

- Display Unit connection cable K 145, 100 cm long
- <IEC 625> Bus cable K 343, 120 cm long

At extra cost

- Adapter plug IEC 625/IEEE 488 (S 834)
- Protective cover set SD-3
- Instrument case TPK-3
- Transport case TPG-43
- 19" conversion kit
- Camera mounting frame FVR-8

---

1) Compatible with CCIR television standards

1.9 ORDERING INFORMATION

Display unit SG-4	BN 957/01
Accessories (at extra cost):	
Protective cover set SD-3	BN 700/00.23
Instrument case TPK-3	BN 626/09
Transport case TPG-43	BN 621/43
19" conversion kit	BN 700/00.03
Camera mounting frame FVR-8	BN 980/00.01

2 TECHNICAL DETAILS

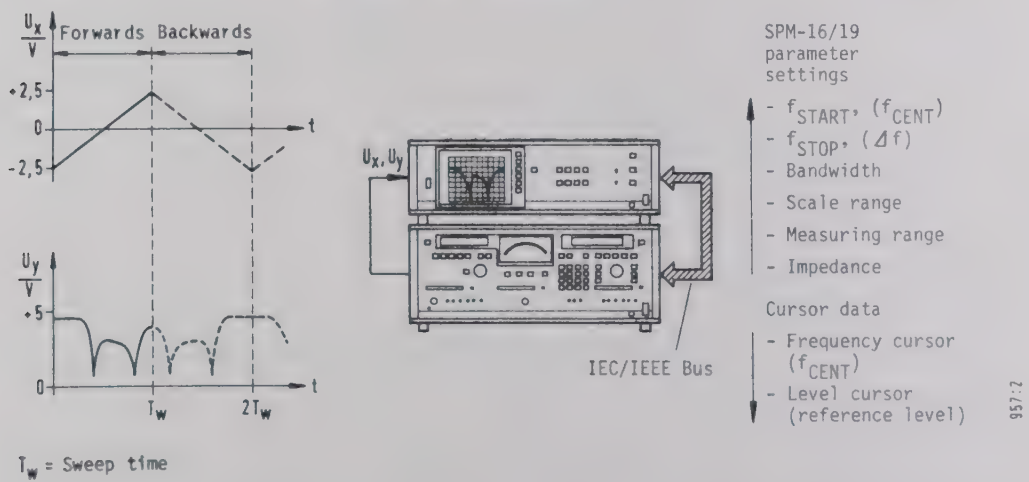
2.1 INTRODUCTION

The Display Unit, as a component part of sweep measuring setups, permits continuous display of measured traces and frequency spectra. Due to the use of microprocessors and highly integrated circuits, level meters with sweep facilities such as the SPM-16 and SPM-19 today have a high degree of measuring ease, versatility, and measuring accuracy. Full programability and thus the use in automatic measuring systems is provided by the <IEC 625>/IEEE 488 interface. The Display Unit SG-4 was developed in order to permit full utilization of all of these characteristics of the level meter in sweep mode. It digitizes and stores the analog level and frequency information, and then displays this information as a flicker-free and reproducible trace on a 7" flat screen. Digital image storage and microcomputer control created the prerequisites for additional measuring facilities which resulted in considerable advances with respect to trace display and evaluation compared with older display units such as the SG-2 or SG-3.

2.2 FUNCTIONAL SEQUENCE

After input of parameters (f_{START}, f_{STOP} etc.) in the Level Meter, the key functions are interpreted and an interrupt request is transmitted to the SG-4. The SG-4 fetches the current front panel settings via the IEC/IEEE bus and processes the level and frequency information to form a graticule which is displayed on the 7" monitor; see Fig. 2-1. The y axis (level axis) is generated (with an 80, 20, or 1 dB scale) from the data "scale range", "measuring range" (and possible "reference level") and marked with the calculated values. The x axis (frequency axis) is generated from the data "f_{CENT}", "Δf" (or "f_{START}", "f_{STOP}") and marked with integral values.

The actual "measured voltage Uy" and "deflection voltage U_x" (see Fig 2-1) are connected via a separate cable to the Display Unit. These analog signals are digitalized continuously in sweep mode and placed in a buffer. After further processing of the digital values by the microcomputer circuit, they are written into the previously generated graticule.



T_w = Sweep time

Fig. 2-1 Transfer of the analog signals U_x, U_y from the Level Meter to the Display Unit, and the mirror image presentation of the swept signal from the Level Meter

2.3 MODULES OF THE DISPLAY UNIT

The Display Unit consists of the following modules:

- Input circuit
- Analog/digital converter
- Buffer
- Microprocessor control (CPU) with memory
- Monitor control with screen
- <IEC 625> interface.

The arrangement of the modules, particularly of the printed circuit boards, is shown in Fig. 5-2. The most important circuits are explained in more detail below on the basis of the simplified block diagram shown in Fig. 2-2.

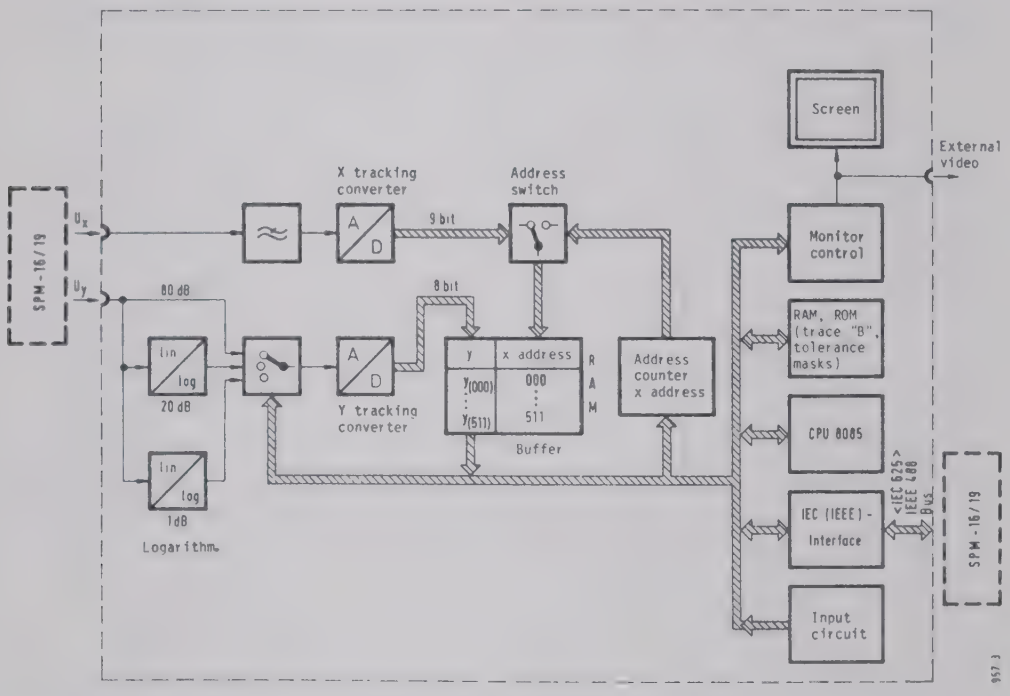


Fig. 2-2 Simplified block diagram of the SG-4

2.3.1 ANALOG/DIGITAL CONVERTER

The display unit receives the measured voltage U_y with a value between 0 and 5 V and the deflection voltage U_x with a value between -2.5 V to +2.5 V from the level meter.

Measured voltage U_y

In order to permit the 1 dB and 20 dB scales to be divided into steps of 1/100 dB and 1/10 dB, respectively, over the whole dynamic range, the measured signal U_y is logarithmized before A/D conversion. In the case of the 80 dB scale range, the signal is logarithmized in the Level Meter; the signal is connected directly. In the A/D converter, a so-called "tracking converter"

(see Fig. 2-3), the measured voltage U_y is converted into an 8-bit data word (resolution: 1/256) and passed to the buffer.

Deflection voltage U_x

The voltage U_x which is proportional to the measuring frequency, passes via a low-pass filter to the A/D converter (X tracking converter, see Fig. 2-3), which generates a 9-bit data word. The constant voltage sweep of U_x (5 V) is divided into 511 steps, digitilized, and used for organization of the buffer; addresses 000 to 511.

The low-pass filter located before the A/D converter is provided to suppress interference components which can occur during rapid frequency changes.

Tracking converter (U_x)

The principle of operation of the tracking converter is explained on the basis of Fig. 2-3. The circuit consists basically of an A/D converter, a counter, and a comparator.

Before the U_x signal is connected to the input of the tracking converter, it is raised by +2.5 V, which means that only positive voltage values have to be processed.

If the input voltage U_x = 0 V ($\cong f_{START}$), the output data word is "000". If U_x rises by at least ΔU (ΔU = 5 V/511) during the forward sweep, the voltage U_k (> 0 V) is generated at the input of the comparator. The output signal increments the counter by "1". (This signal can assume only the states "increment" or "decrement"). The new counter value "001" in turn causes a current flow in the A/D converter which generates the voltage I · R across resistor R. This voltage causes the comparator voltage U_k to be raised again (0 V) which means that incrementation of the counter is terminated after one cycle. The counter value then remains unchanged until the deflection voltage has risen to 2 ΔU (or has dropped to 0); the cycle is then repeated.

The counter value is the digital value of the deflection voltage U_x; it is passed to the buffer. The counter also supplies an "address change pulse" just before the x value changes. This signal causes the digital y value to be written into the buffer. Automatic gain and offset adjustment is provided for analog/digital conversion of U_x in order to compensate for tolerances of the level meter. This is not necessary for the measured voltage U_y, as the output of the Level Meter used for this is calibrated. Conversion of U_y into a digital signal is carried out as described above in the Y tracking converter.

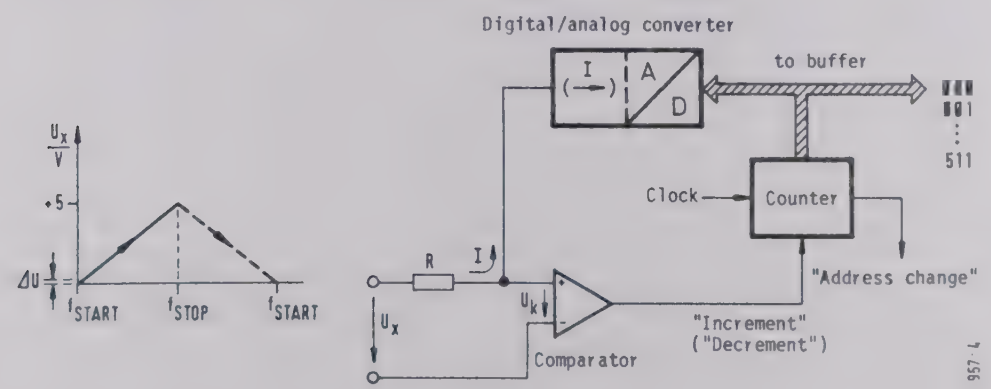


Fig. 2-3 Principle of tracking converter (e.g. for U_x)

2.3.2 BUFFER

The Y tracking converter operates with a clock which is 80 times faster than that of the X tracking converter. During digitalization of one x value (address), a specific number of y values are created, depending on the selective sweep time. Of these values, the minimum and maximum values are determined during one x interval with the duration "sweep time/511" and written into the buffer, i.e. two y values are stored for each x address; see also display of measured trace in Section 2.4.

In addition, a control byte is written in order to identify forward and backward sweep (increment - decrement) and to determine whether the current y value (y_{min}, y_{max}) has changed since the last sweep. The capacity required in the buffer (RAM) is thus 3 x 512 x 8 bits.

Writing into the buffer

The signal "address change", which can assume the states 1 and 0, initiates writing (= 1) of the y value (i.e. y_{min} and y_{max}) depending on the selected operating mode "manual tuning", "sweep", or "step mode". By combining this with the signal "pen down", which identifies the sweep direction and is supplied by the Level Meter on a separate line (K 145), it is possible to control when y values are to be written into the buffer and displayed on the screen.

Reading the buffer

The instantaneous values for x (frequency) and y (level) are shown on the screen by a marker "+". For this purpose, the computer requires the current x and y values as provided by the tracking converters. For display of the trace, the computer reads the digital y words from the buffer, the buffer being addressed by the address counter. During reading of the buffer, the control byte is erased in order to permit detection of whether or not memory position has been rewritten since the last read operation. In the operating mode "autostep" and "autotrack", an indicator is set in the control byte to show whether or not this is a valid measured value. The computer then connects the valid measured values together and displays them on the screen as a polygon curve.

2.3.3 FURTHER PROCESSING OF THE DATA

The value pairs (x/y) stored in the computer are processed further and displayed on the screen according to the operating mode. All of these additional functions are implemented purely in the software. In order to achieve a stationary display on the screen, the complete image information such as measured trace, graticule, and alphanumeric characters is stored in an image refresh memory. As the beam passes over the screen, the image refresh memory is read simultaneously. Depending on the contents of this memory, the beam is unblanked or blanked. One bit in the image refresh memory is allocated to each pixel on the screen.

Fig. 2-4 shows this principle. The computer causes the character and vector generator to set up the image information in the image refresh memory. The control directs the beam of the monitor with a blanking and synchronization signal (A, S) and addresses the memory bit corresponding to the beam position (video signal, B). These three signal components are combined to form the BAS signal (composite video signal) in accordance with the appropriate standard and passed to the monitor.

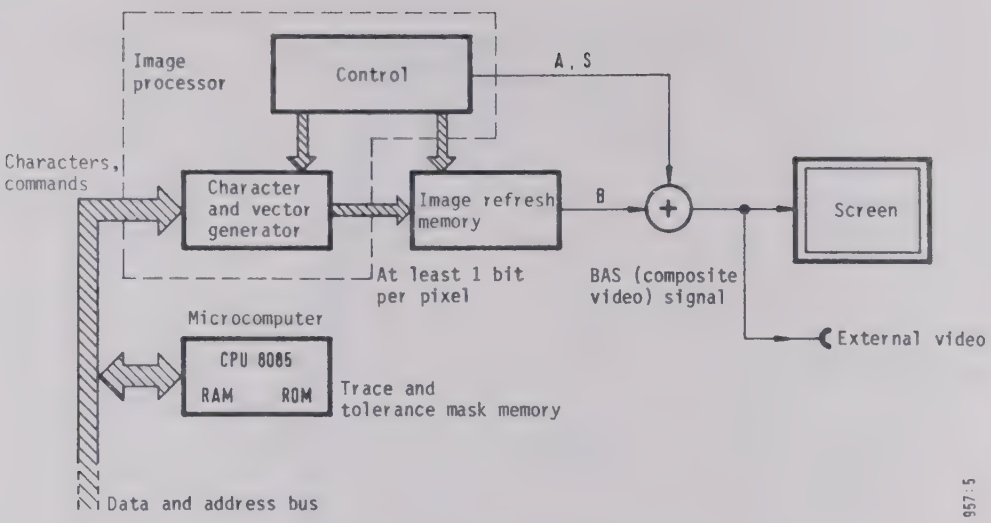


Fig. 2-4 Pixel-oriented screen of the SG-4

2.4 DISPLAY OF MEASURED TRACES ON THE SCREEN

The resolution of the sweep traces is determined by the analog/digital converters. Whereas the deflection voltage U_x for display of the sweep width Δf is quantized in 511 steps (9-bit system), the measured voltage is quantized in 256 steps (8-bit system).

This method of displaying the measured traces permits, in addition to specific addressing of single pixels (e.g. with the cursor), storage of sweep traces for internal evaluation facilities such as "trace difference" or "generation of tolerance masks" by connecting pixels defined by the operator.

511 pixels are normally sufficient for display of a sweep trace if one y value is displayed per x value. In the SG-4, two y values namely y_{min} and y_{max} are stored per x value, i.e. during one x interval (see also x quantization step in Fig. 2-5). The screen control subsequently connects y_{max} to y_{min} by injecting further pixels, thus guaranteeing a continuous trace; see Fig. 2-5.

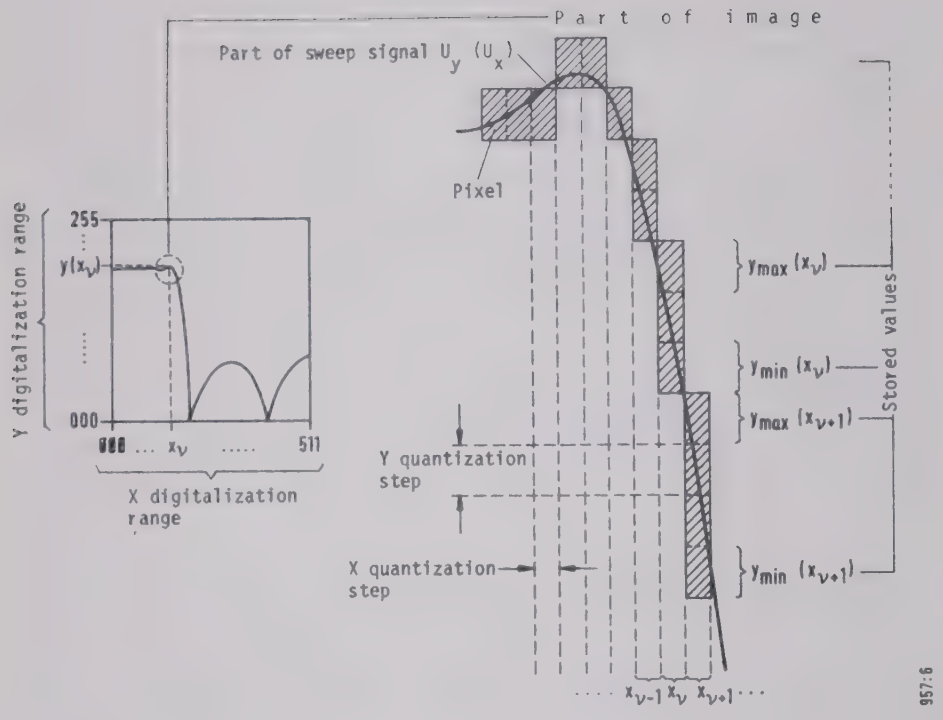


Fig. 2-5 Display of a trace section on the screen (shaded)

2.5 "AVERAGING" IN THE SG-4

If the function "AVRG A" is selected in sweep mode, the digital y values are successively averaged.

The maximum and minimum values (y_{min}, y_{max}) are averaged and displayed separately. For this reason, an averaged curve on which white noise is superimposed appears as a noise band (see Fig. 3-16).

An average value $\bar{y}_i$ (maximum or minimum value) displayed on the screen is calculated from the average value $\bar{y}_{i-1}$ of the preceding sweep pass (forward) and the current value y_i. Fig. 2-6 shows the timing sequence of averaging which results when the function "AVRG A" is selected (e.g. for the maximum values $y_{i\ max}$). At the start of the averaging operation, the current measured values y_i are weighted with a continuously reduced factor (during the first 5 forward sweeps). After the 5th forward sweep, averaging is carried out with constant weighting (1/16). This provides good settling, i.e. rapid smoothing of the trace, particularly for traces on which noise is superimposed.

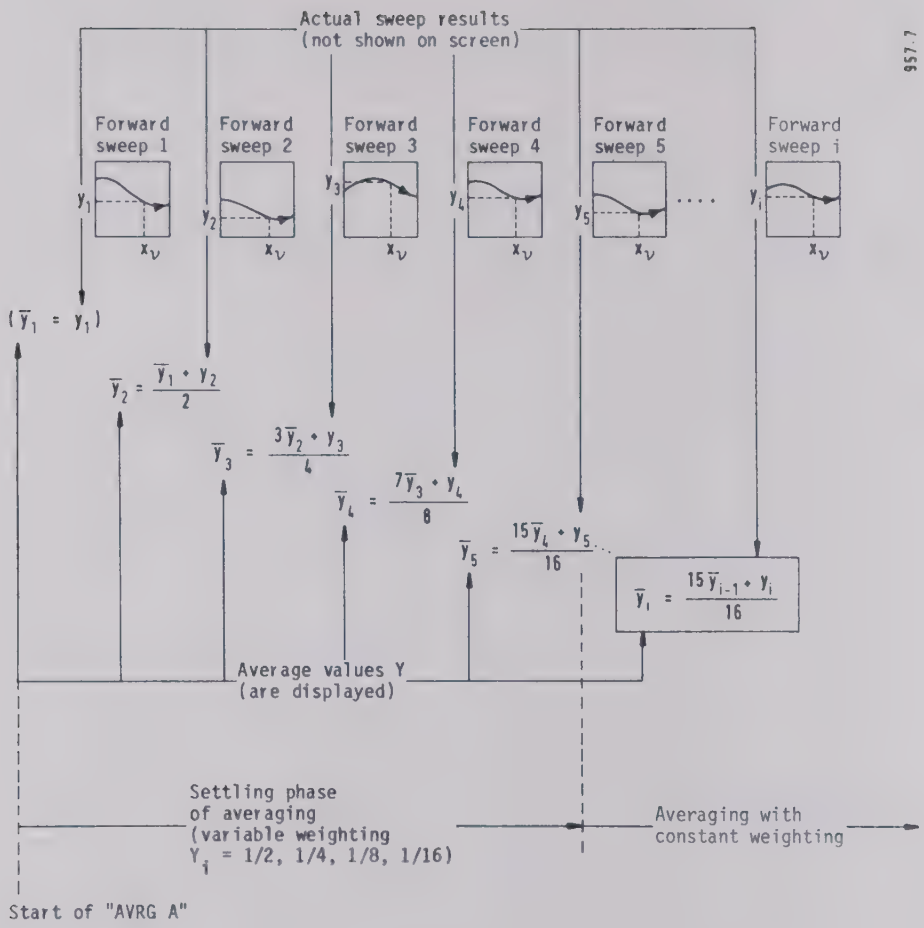


Fig. 2-6 Principle of averaging in the SG-4 (e.g. for maximum values y_{max})

Important Safety Instructions

A.C. power line voltage

The operating voltage of the instrument should be the same as the a.c. line voltage, so check whether or not the two voltages are equal.

Safety Class

This instrument is categorized as Safety Class I according to VDE 0411 or IEC Publ. 348. The power cord delivered with the equipment has a protective ground conductor. The a.c. power plug must be plugged into an a.c. power receptacle that has a third wire to ground, except in rooms that are particularly certified otherwise. Any disconnection of the protective ground conductor either inside or outside of the instrument is not permitted.

Connection to measuring circuits presenting hazards to personnel

Before the connection is made to a hazardous circuit, a protective ground connection, for protection against the measurement circuit, ought to be connected to the enclosure. In case the protective ground conductor of the a.c. power line can also assume this protective function, the a.c. power connection should be established first of all. If the measuring circuit has an inherent protective ground conductor, then this conductor must be connected to the enclosure before a connection is made to the measuring circuit.

Defects and Exceptional Conditions

When it can be assumed that safe operation is no longer possible, the equipment should be taken out of service and inadvertent operation should be prevented.
This occurs when

- the equipment shows external signs of damage
- the equipment no longer operates
- after being overstressed in any way (e.g. storage, transport) so that the tolerable limits are exceeded.

Fuses

Only specified fuses are permitted for use.

Opening the Instrument

After the covers have been removed or when components are removed with tools, certain components that operate with applied voltage could be exposed. And also connection points might be carrying a voltage.
Therefore, before the instrument is opened for inspection, all voltage sources should be disconnected.
But sometimes calibration, maintenance or repairs require that the instrument be open and operating with applied voltage. So only experienced craftspersons who understand the dangers associated with working on instruments that have exposed voltage points should undertake the job.
Capacitors can retain a voltage charge even after the instrument has been disconnected from voltage sources. Thus, the circuit diagrams should be observed.

Repairs, Replacement of Components

Repairs must be done according to correct technical practice. With that, particular attention must be paid to the characteristics of construction. None of the safety precautions should be changed, especially for leakage paths and air gaps, and separation by insulation must not be reduced.
Only original replacement parts ought to be used. Other replacement parts are only permitted if the safety and protection against human injury are not degraded through the use of non-original components.

Safety Testing after Repair and Maintenance

Testing of the protective ground conductor in the power cord for the instrument:

The resistance of the protective ground conductor shall be measured. It should be $<0.5\,\Omega$. The power cord should be bent and kinked during the measurement so as to reveal any intermittent connection. This gives evidence of a defective power cord.

Testing the insulation of the a.c. power circuit:

The insulation resistance is measured at 500 V between the a.c. power connection and the protective ground conductor connection. For this measurement, the instrument's power switch should be ON.
The insulation resistance ought to be $>2\,M\Omega$.

3 COMMISSIONING AND OPERATION

3.1 UNPACKING THE INSTRUMENT AND PUTTING INTO SERVICE

The SG-4 instrument is shipped in special packing materials which have been subjected to comprehensive stress tests in the Wandel & Goltermann factory.

This guarantees that the Display Unit will arrive without damage even if treated roughly. The instrument should be removed carefully from the packing materials at the appropriate sides. We recommend that the original packing materials be retained for possible subsequent shipping. If this is not done, please see the following notes.

3.1.1 SHIPPING NOTE

Shipping of the SG-4 without damage can be guaranteed only by correctly designed packing materials. If the original packing materials have been lost, we recommend that the instrument be packed as shown in Fig. 3-1.

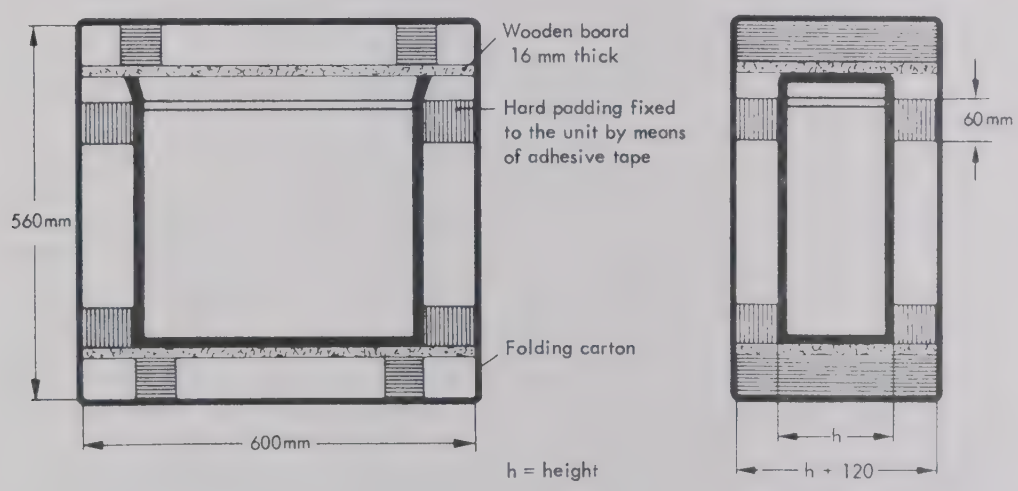


Fig. 3-1 Packing note

3.1.2 TRANSPORT IN THE INSTRUMENT CASE TPK-3 OR TRANSPORT CASE TPG-3

The Transportation Container TPK-3 is intended to protect the SG-4 against dust and mechanical damage during light transport (e.g. in a motor vehicle). It also provides suitable protection against splashwater. Additional protection of the screen and the controls against impact is provided if the Rear Cover SD-3 is placed on the front of the SG-4 before placing it in the instrument case. For transport and more stringent climatic or mechanical conditions (e.g. by rail or air), we recommend the use of the Transport Case TPG-3 which protects the instrument against extreme ambient conditions.

3.1.3 USE IN 19" RACKS

The case dimensions of the SG-4 are matched to DIN Standard 41 494 and the American Standard ASA C 83.9 "racks and front panels". The instrument is thus suitable for installation in 19" racks; it is necessary only to increase the front panel dimensions by fitting two mounting brackets as shown in Fig. 3-2.

The complete 19" conversion kit including mounting screws is available under the Order Number BN 700/00.03. Before installation, the instrument feet on the bottom side and the locating pins on the top of the instrument should be removed (see Fig. 3-2).

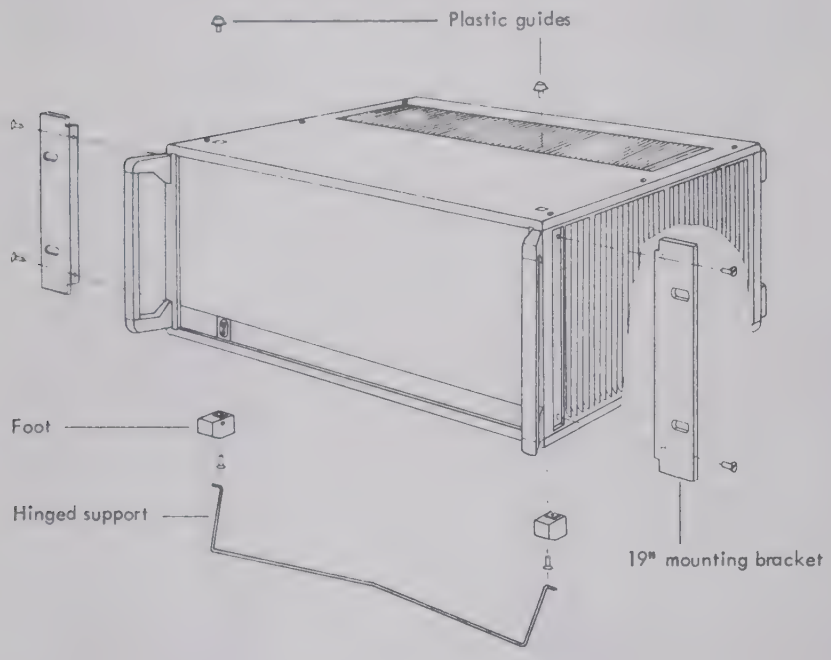


Fig. 3-2 Converting the desk-top unit for rack installation

Caution: If the instrument is installed in a cabinet, care must be taken that the upper limit of the rated range of use of the ambient temperature is not exceeded (see Section 3.1.4). Generally, the following measures are necessary:
A gap of one height unit (44.4 mm) must be left between instruments.
If necessary, a fan must be fitted to extract the heat from the cabinet. Suitable filters should be provided in order to prevent entry of dust into the cabinet.

3.1.4 INSTALLING THE INSTRUMENT

The Display Unit SG-4 can be operated at ambient temperatures between +5 and +40 °C. If used within larger systems or installed in racks, care must be taken that this temperature range is not exceeded (e.g. by suitable spacing between instruments, see Section 3.1.3).

Temperatures between -40 and +70 °C are permitted for storage or transport. In this case, we recommend that the CRT and the controls be protected against mechanical damage, dust, and splash-water by fitting the Transportation Protective Covers SD-3 on the front and rear sides.

The Display Unit can be mounted at a slight angle by swinging out the stand mounted between the front feet. The SG-4 will operate reliably in this position.

3.1.5 POWER SUPPLIES

The Display Unit SG-4 can be operated from AC voltages with frequencies between 47.5 and 63 Hz. The enclosed mains cable should be used for connection to the outlet. If a different mains cable is used, ensure that a protective conductor is fitted. When the instrument leaves the factory, the mains voltage selector on the rear of the SG-4 is set to 220 V. Depending on the local mains voltage, this selector can be turned to 110, 117, 127, 227 or 235 V with the aid of a screwdriver. The selector is mounted above the mains connector (see Fig. 3-7).

If the mains voltage selector is set to 110, 117, or 127 V, the fuse element of the equipment fuse must be replaced. The following fuse values must be used:

Mains voltage	Fuse
220, 227, 235 V	0.63 slow blow
110, 117, 127 V	1.25 slow blow

Spare fuse elements are provided on the rear of the instrument.

3.1.6 CONNECTING THE DISPLAY UNIT TO THE LEVEL METER SPM-16 OR SPM-19

IEC/IEEE Bus connection

The SG-4 is connected to the Level Meter SPM-16 (or SPM-19) via the enclosed cable K 343 as shown in Fig. 3-3. For this purpose, the Level Meter must be equipped with the appropriate remote control board (BN 853/02).

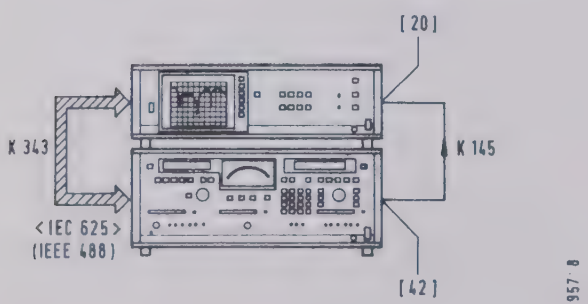


Fig. 3-3 Connection of the SG-4 to the Level Meter ([20], [42], sockets for K 145)

The SG-4 is already equipped with the remote control board (BN 958/01). The instrument address must be set with the address switches on the rear cover (see Fig. 3-4) such that it is one less than the address of the Level Meter. In the factory, the remote control boards are set to the following standard addresses:

SG-4: Ø, SPM-16/19: 1

Settings of the address switches on the SG-4 (see Fig. 3-4):

A1 to A5 on the right:	OFF ≙ Ø
LON (listen only) to the right:	OFF ≙ Ø
TON (talker only) to the right:	OFF ≙ Ø
SC (system control) to the left:	ON ≙ 1

If the combination of SPM-16(19) and SG-4 (possibly with other IEC/IEEE controllable instruments connected to the bus) is controlled by a computer, then the switch "SC" must be set to the right (OFF).

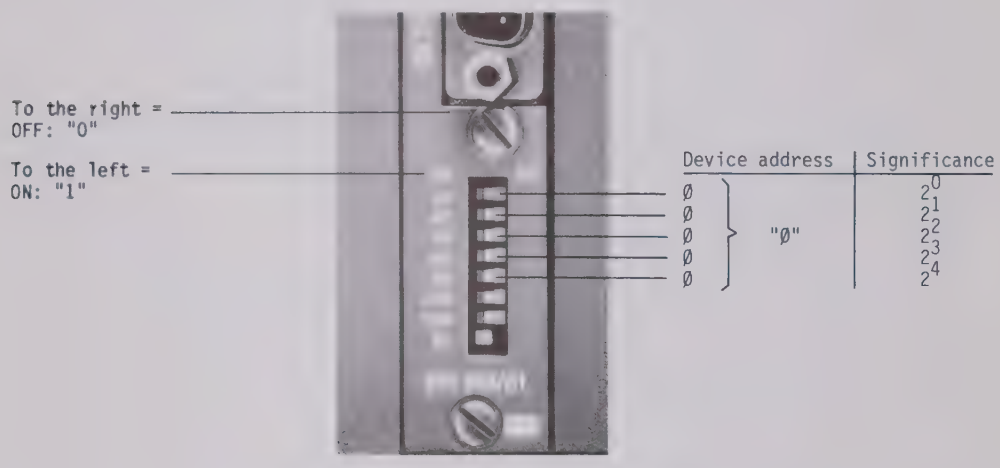


Fig. 3-4 Address switches on rear of SG-4

X, Y signal connection

The actual measured voltage (Y signal) and deflection voltage (X signal) are transferred via the cable K 145; this is connected between socket [20] (SG-4) and socket [42] (SPM-16/19). The pin assignments of sockets [20] and [42] are shown in Fig. 3-5.

Pin	Signal name	
4	Switch to reference line voltage	
5	Pen lift function	H ≙ Pen up
6		H ≙ Pen down
9	X deflection voltage	
10	Y deflection voltage	
12	Interrupt for SG-4	
13	Not used in SG-4	
14	Ground	

Fig. 3-5 Pin assignments of Display Unit socket

3.1.6.1 Use of the SG-4 with older versions of the Level Meters SPM-16/19

The Display Unit SG-4 can basically also be connected to older versions of the Level Meters.

SPM-16/19, Series A, B must be modified in both hardware and software. The changes can be implemented by one of our service engineers.

SPM-16, Series C / SPM-19, Series C-E: After both instruments have been switched on, the SPM-16/19 is switched to remote control operation by the SG-4 (red LED alongside pushbutton [2] on). In order to set the Level Meter, it must be switched back to manual mode.

For this purpose, the pushbutton [7] "HOLD" on the SG-4 must be depressed (red LED on). After the SPM-16/19 has been set, the "HOLD" function of the SG-4 is switched off (red LED off). The new setting parameters are now read by the Display Unit.

On newer versions of the Level Meters (SPM-16 Series D or later, SPM-19 Series F or later), with the exception of instruments with volt display (SPM-16, BN 874/03 and SPM-19, BN 829/03), it is not necessary to depress the "HOLD" pushbutton to transfer the current parameters of the Level Meter[1].

3.1.7 PUTTING INTO SERVICE

After both instruments have been switched on (power "on"), an internal test and automatic calibration are first carried out. The test and calibration phase (a few seconds) is signalled by the following information on the Display Unit:

TEST and

CAL.

After this, the SG-4 is ready for use:

The instrument sets itself automatically to the key functions which were valid before it was switched off.

A standard setup appears if the built-in buffer battery for data retention was insufficiently charged, or if it was disconnected from the CMOS memories during repair work.

---

1) The auto-set function is possible with Level Meters SPM-16 Series E or later and SPM-19 Series K or later. Basically, the function can also be implemented on older instruments (software modification).

3.1.7.1 Error messages after switching on the instruments

Error display on monitor	Occurrence of error message	Possible cause
IEC/IEEE - BUS ?	After switching on SG-4 and after test phase (CAL) If SPM-16/19 is blocked	- Cable K 343 not connected - Bad ground contact - Interface board of level meter not correctly inserted - SPM-16/19 switched to remote control[1)]
ADDRESS ?	After switching on the SG-4 and after test phase (CAL)	- Manual mode: address switch "SC" in "OFF" position - Computer mode: system address is unknown
SPM ?	Immediately after switching on the SG-4	- Cable K 145 not connected - Bad contact - Level Meter not switched on

Table 3-1 Error messages upon switching on the display unit

1) Depress pushbutton "LOCAL" on SPM-16/19 (red LED off)

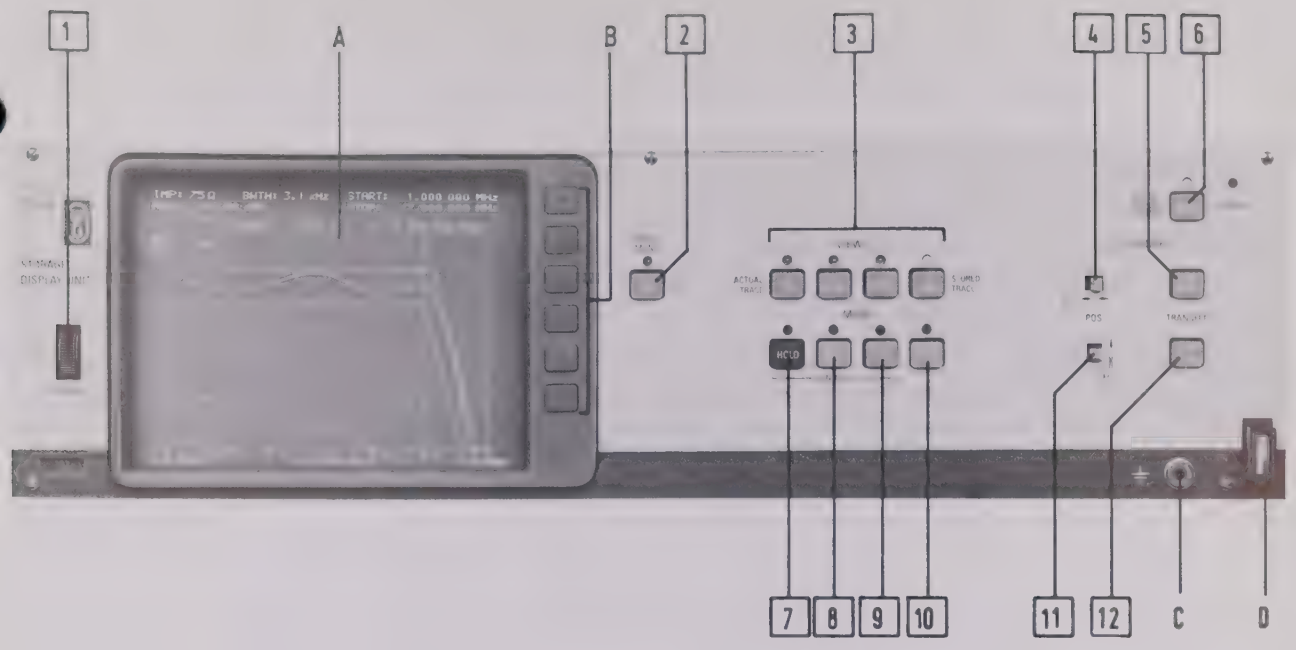


Fig. 3-6 Front view of the SG-4 (BN 957/01)

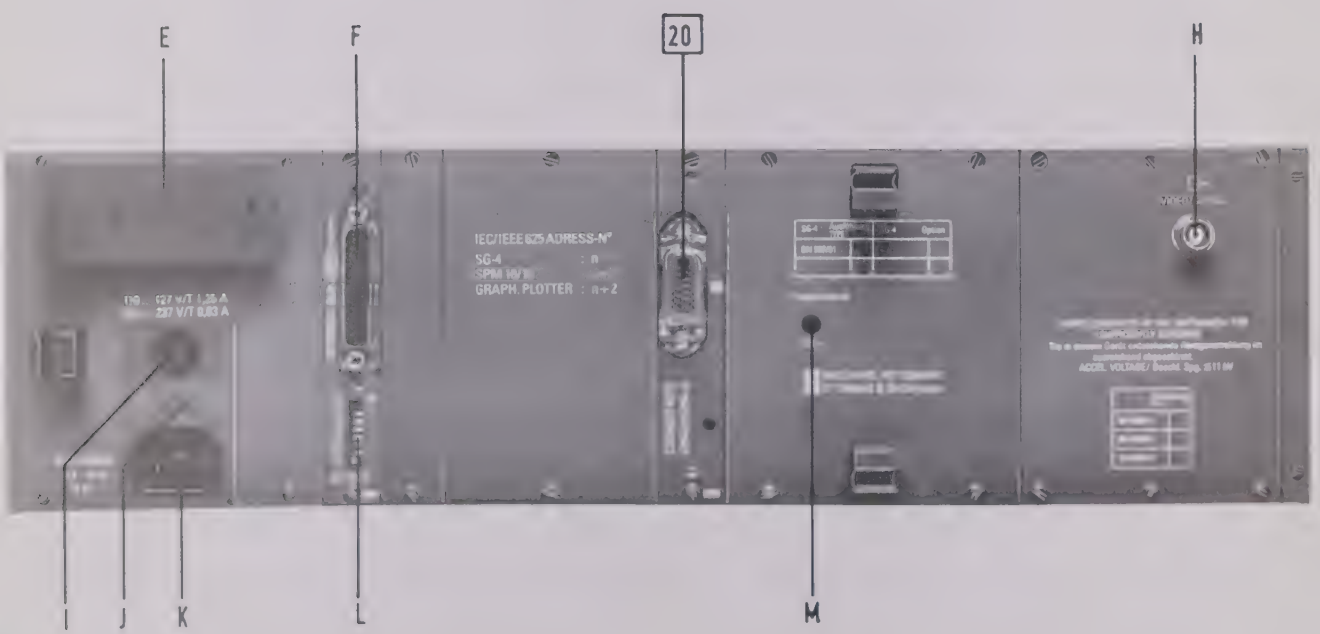


Fig. 3-7 Rear view of the SG-4 (BN 957/01)

Code number of control	Function	Abbreviation in circuit diagrams
[1]	Intensity control for adjustment of screen intensity.	5 P 2
[2]	Pushbutton for calling the scale menu; see monitor display in Fig. 3-8.	2 S 1
[3]	Measured trace display,	
	A — actual measured trace.	2 S 10
	A-B — Difference between actual trace and reference trace stored in B.	2 S 13
	A&B — Simultaneous display of actual and reference traces.	2 S 16
	B — Display of reference trace stored in B.	2 S 19
[4]	Rocker switch for frequency cursor movement (vertical line)	2 S 25, 26
[5]	→ f_{CENT} — Pushbutton for transferring frequency cursor to f_{CENT} memory of level meter (SPM-16/19).	2 S 29
[6]	LOCAL — Pushbutton for switching to manual control during remote control operation (IEC/IEEE bus).	2 S 37
[7]	HOLD — Pushbutton for freezing the complete screen contents.	2 S 11
[8]	MAX HOLD — Pushbutton for displaying the maximum level value of the actual measured trace A which occurred within the corresponding display column.	2 S 14
[9]	AVRG A — Pushbutton for averaging of the current measured trace A.	2 S 17
[10]	STORE A → B — Pushbutton for transfer of current measured trace A to memory B.	2 S 20
[11]	Rocker switch for level cursor adjustment (horizontal line)	
[12]	→ REF L — Pushbutton for transfer of level cursor to REF memory of SPM-16/19.	2 S 30
A	C a t h o d e r a y t u b e (BN 980/01) - For display of the measured traces selected with [3] in a calibrated graticule. Actual parameters are displayed above the graticule. - For display of the scale menu.	
B	Soft keys; function of each key is assigned in the scale menu.	93 S 2
C	Ground socket	1 Bu 1
D	Mains switch	1 S 1

Table 3-2 Controls on the front of the SG-4; see Fig. 3-6

Code number of control	Function	Abbreviation in circuit diagrams
[20]	Display Unit input; 14-pin socket for connection cable K 145 from SPM-16/19.	3 Bu 1
E	Accessory compartment for spare fuse, assembly wrench, and hexagon wrench.	
F	<IEC 625> Interface Board, BN 958/01, with <IEC 625> Bus connector for connection to SPM-16 or SPM-19 and for control by an external computer.	
H	Video output for external monitor or video plotter.	
I	Mains fuse	1 Si 1
J	Mains voltage selector	1 S 1
K	Mains connector	1 Ste 1
L	Switches for IEC Bus address, listener/talker mode, and controller mode of the SG-4.	
M	Potentiometer for level adjustment of video signal (output H).	92 P 1

Table 3-3 Connectors and miscellaneous items on rear of SG-4; see Fig. 3-7

3.2 CONTROLS AND CONNECTIONS

The front panel of the SG-4 is divided into the monitor unit with the soft keys on the left and the control panel with the fixed key functions on the right.

The control panel consists basically of the key rows "VIEW" for selection of traces to be displayed and "MODE" for evaluation of the traces. The key "SCALE MENU" on the right of the 6 soft keys permits the scale menu to be called. Each key on this control panel has a corresponding LED which lights when the function is active.

To the right of these are the setting controls "CURSOR" for insertion and movement of the cursors and the "LOCAL" key with LED which indicates whether the SG-4 is operating in remote control mode (REMOTE) or manual mode. The rear of the instrument carries the connection sockets for the analog and digital signals from the SPM-16/19 and for extraction of the video signal for external further processing of the screen contents. The switch for the IEC bus address is also mounted on the rear of the instrument; it is not necessary to remove the interface board to set the address. The abbreviations of controls and sockets used in the operating instructions are shown in Figures 3-6 and 3-7, which are on a fold-out page.

The relationship between the abbreviations (these are normally in the form of digits enclosed in square brackets) and the designations in the circuit diagrams of the servicing instructions are shown in Tables 3-2 and 3-3. The numbers enclosed in square brackets in the tables and text agree with the numbers printed within "boxes" on the front and rear sides of the instrument.

3.2.1 SCREEN INTENSITY

The intensity of the measured trace and the background display (graticule, etc.) can be modified with the intensity control [1]. Turning upwards increases the intensity and turning downwards reduces it.

The actual measured trace is displayed with higher intensity than the background information and reference trace (pushbutton "A & B" depressed). In order to provide a clear distinction between the two traces, it may be necessary to slightly reduce the screen intensity with the intensity control [1].

3.3 S C A L E M E N U

In addition to the setting facilities provided by the control panel of the SG-4, it is possible to activate additional functions with the aid of the scale menu and the soft keys on the right side of the screen. Soft keys are unmarked keys to which specific functions are assigned by the software. The soft keys reduce the number of keys on the front panel and avoid the necessity for multifunction keys.

The scale menu is activated by depressing the key

- SCALE MENU [2] (green LED on)

The monitor display shown in Fig. 3-8 appears.

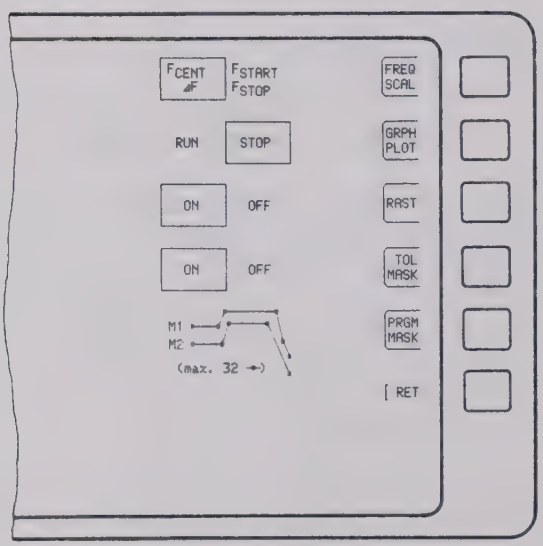


Fig. 3-8 Monitor display "Scale menu 1"; list of possible functions

The corresponding functions are displayed on the right edge of the screen immediately alongside the corresponding soft keys: [...] The soft-key functions are explained in detail in Table 3-4.

After a function has been executed, the "scale menu 1" is switched off by depressing key [2] (LED off). It is also possible to return to the monitor display "VIEW" (measured trace display) by using the soft-key function "RET".

The soft-key functions "FREQ. SCAL", "RAST" and "TOL-MASK" can be switched directly without displaying "scale menu 1" beforehand.

Soft key name	Function
FREQ SCAL	Depression of this key permits selection of either relative frequency calibration "$F_{CENT}/\Delta F$" or absolute frequency calibration "F_{START}/F_{STOP}" of the frequency scale. This can be switched directly (without activating the scale menu)
GRPH PLOT	Graphic plotter operation, see section 3.9.2 Depression of this key causes the screen contents (depending on the position of soft key "RAST") to be plotted: "RUN" Second depression of the key causes plotting to be stopped: "STOP"
RAST	Key set to "ON": Measured trace and background display are plotted Key set to "OFF": Only measured trace is plotted.
TOL MASK	If a tolerance mask is stored, depression of this key causes display: "ON" or deletion: "OFF" of the mask. This can be switched without activating the scale menu.
PRGM MASK	Depression of this key results in a monitor display which provides all information necessary for programming of tolerance masks; see Fig. 3-19. In this function, the soft keys are redefined.
[RET	Depression of this key returns to the "measured trace display" mode.

Table 3-4 Soft key functions after selection of "scale menu 1" with key [2]

3.4 BACKGROUND DISPLAY

3.4.1 CALIBRATED GRATICULE

The measured traces - the actual trace A or the stored trace B, both traces together or their difference - are displayed within an electronically calibrated graticule; the measured values can be read-off without parallax errors. The markings of the linear level scale and the number of horizontal lines are matched optimally to the selected measuring range. The levels are displayed in dB, dBm, or dBm0 (where the dBr value is displayed on the screen line (REF)). The vertical lines of the graticule are marked with the absolute frequency or with the center frequency and the corresponding offsets from this center frequency, depending on what is selected on the display unit. For selection, see Table 3-4, soft key function "FREQ. SCAL".

Fig. 3-9a shows an example with the calibration lines widely spaced:
- Level axis divided into 5 divisions, 1 dB scale range
- Frequency axis divided into 10 divisions (minimum)

Fig. 3-9b shows an example with close spacing of the calibration lines:
- Level axis divided into 8 divisions, 80 dB scale range
- Frequency axis divided into 18 divisions (maximum).

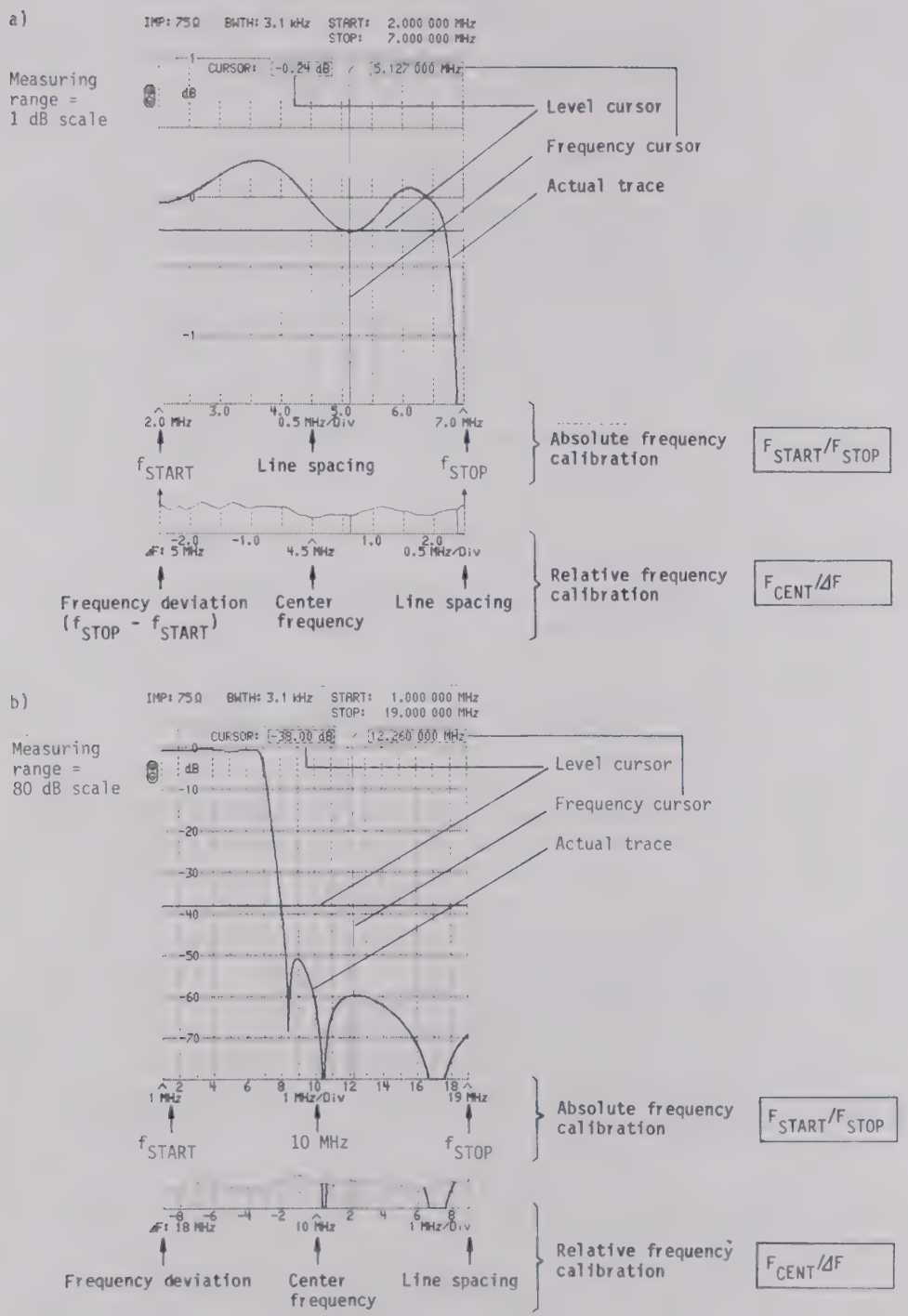


Fig. 3-9a, b Examples of automatic allocation of graticule lines and marking when the measuring range ([10] SCALE) and the start and stop frequencies are entered (SPM-16/19)

The division of the frequency axis of the graticule is carried out automatically in the SG-4. An optimum set of divisions is determined from the start and stop frequencies and the frequency lines are marked with integral values.

3.4.2 CURSOR

Precise measurement is carried out with the aid of separate level and frequency lines "CURSOR", the level and frequency values being displayed with a maximum resolution of 0.01 dB (1 dB scale range) and 0.1 Hz ($f_{STOP} - f_{START}$ or $\Delta f/511 \leq 511$ Hz); see Fig. 3-9a, b (screen line "CURSOR").

The cursor lines can be shifted over the whole width and height of the graticule, permitting selection of any point within this area.

Resolution of display: on 80 dB scale: 0.33 dB
on 20 dB scale: 0.1 dB
on 1 dB scale: 0.01 dB

Setting of the cursor

- Frequency cursor: rocker switch [4]
  - Slight frequency changes: momentary depression to the right or left.
  - Large frequency changes: hold the switch down; the cursor line moves over the whole graticule.
  - Switching off: move the cursor line to the left out of the graticule; display on screen: ←OFF
- Level cursor: rocker switch [11]
  - Small level changes: momentarily move upward or downward.
  - Large level changes: hold the switch down; the cursor line moves over the whole graticule.
  - Switching off: move the cursor line downwards out of the graticule; display on the screen: OFF↓

3.4.3 ALPHANUMERIC LINES FOR PARAMETER DISPLAY

The actual receive parameters of the SPM-16/19 (setup) are displayed alphanumerically on the top lines of the screen. Each setting on the Receiver is recorded in the SG-4 and displayed on the screen. This makes all necessary information for sweep curves available at a glance and provides an elegant and complete display of results if a log is made by photographing the screen or with a video plotter. The meanings of the various parts of the alphanumeric screen lines are shown in Fig. 3-9c.

Further texts are displayed on the screen lines during programming of tolerance masks; see monitor display "scale menu 2" in Fig. 3-18.

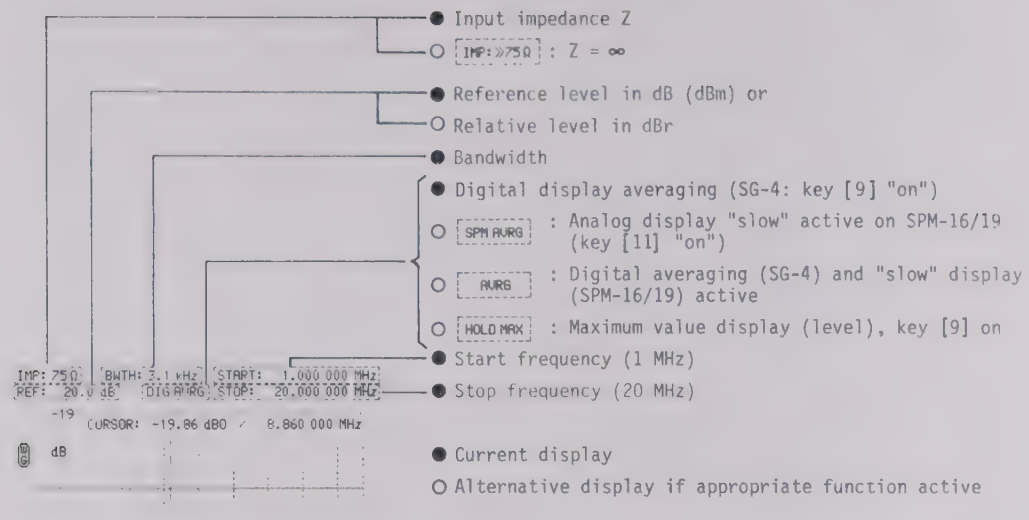

Input impedance Z
IMP: ≫75Ω : Z = ∞
Reference level in dB (dBm) or
Relative level in dBr
Bandwidth
Digital display averaging (SG-4: key [9] "on")
SPM AVRG : Analog display "slow" active on SPM-16/19 (key [11] "on")
AVRG : Digital averaging (SG-4) and "slow" display (SPM-16/19) active
HOLD MAX : Maximum value display (level), key [9] on
Start frequency (1 MHz)
Stop frequency (20 MHz)
IMP: 75Ω BWTH: 3.1 kHz START: 1.000 000 MHz
REF: 20.0 dB DIG AVRG STOP: 20.000 000 MHz
-19
CURSOR: -19.86 dBO / 8.860 000 MHz
dB
Current display
Alternative display if appropriate function active

Fig. 3-9c Display of relevant receiver parameters (and possibly of activated functions of the SG-4)

3.5 MEASURED TRACE DISPLAY - VIEW [3]

3.5.1 ACTUAL MEASURED TRACE "A"

In order to display the actual measured trace, depress

- key "A" (ACTUAL TRACE) on the SG-4 (green LED on).

The key function [2] SCALE MENU is switched off (green LED off).

When the sweep mode of the Level Meter is started with the key "SWEEP⋀⋀" (LED on), the actual result of measurement is recorded during the forward and backward sweep. The trace is refreshed during each sweep. This ensures that any level change is displayed immediately, and simplifies alignment work. If sweep times longer than 3 seconds are used (selected on the SPM-16/19 with rocker switch [17]), a record marker (see Fig. 3-10) which moves backwards and forwards on the measured trace in the sweep rhythm is displayed, indicating the frequency at which the result is currently being read.

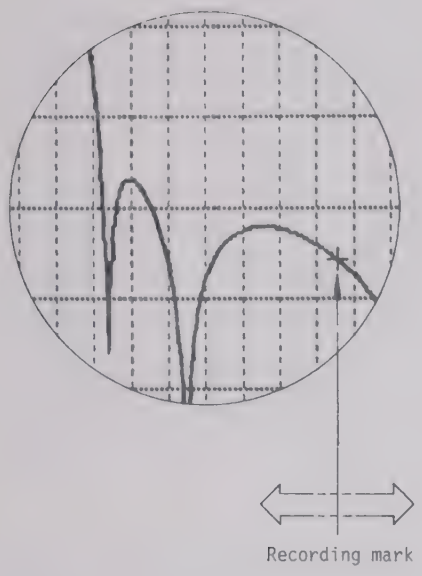


Fig. 3-10 Section of screen: record marker for observation of actual result

3.5.2 REFERENCE TRACE "B"

An actual measured trace can be stored and recalled later. The stored trace B remains available even after the instrument has been switched off (retained for approximately 30 days by built-in battery).

Storing the actual trace A

- An actual result is recorded (LED above "A" on)
- ● Depress key [10] "STORE A→B".

  The red LED above [10] lights momentarily, indicating that the actual result is being transferred to the reference trace memory B.
- The actual trace continues to be recorded (LED above "A" on)

Recall reference trace B

- ● Depress key "B" (STORED TRACE) (LED above "B" is on, LED above "A" is off).

The reference trace is displayed.

NOTE: Depression of the key "STORE A→B" [10] is effective only if the current trace is being displayed; key "A" switched on. If any other key under [3] is currently active, the following message appears on the screen:

3.5.3 ACTUAL TRACE AND REFERENCE TRACE "A & B"

A reference trace can be stored for comparison measurements and subsequently displayed together with the actual trace. For example, the trace shown in Fig. 3-11a is to be used as a reference trace. This is stored as described in Section 3.5.2.

After the test object has been connected, the two traces A (actual trace from test object) and B (reference trace) can be displayed.

- Depress key "A & B" (LED on)

In order to permit clear identification, the actual trace is displayed with higher intensity than the reference trace, see Fig. 3-11b.

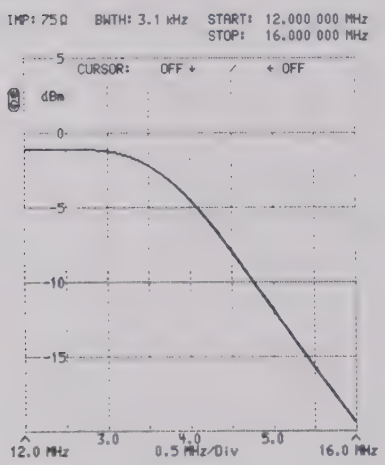


Fig. 3-11a Reference trace stored in trace memory B

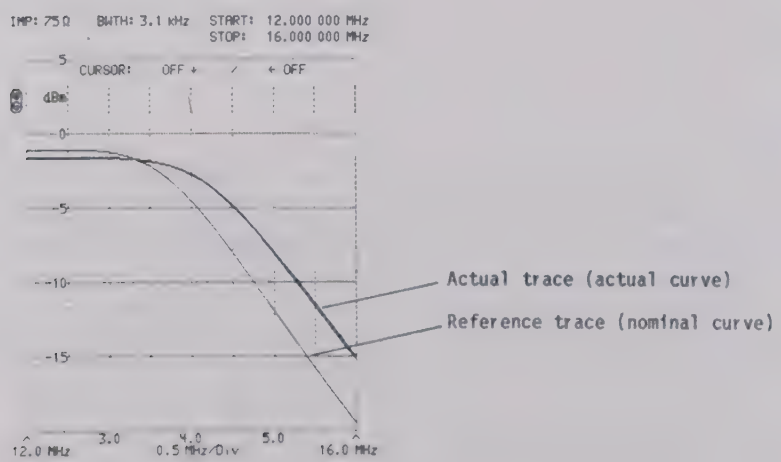


Fig. 3-11b Reference trace and actual trace "A & B"

Caution: 1. If the range (only) on the Level Meter[1] is changed, the following note appears on the screen:

B SCALE -5.00 dB

If, in this example, the actual range was increased by 5 dB compared with the range used for the reference curve (with rotary switch [9] of the SPM-16/19).

2. If other parameters are additionally changed on the SPM-16/19, for example bandwidth, display range, frequency sweep, etc., the following note appears on the screen:

B TRACE PARAMETERS DIFFERENT

Fig. 3-12 shows, using the example of Fig. 3-11b, a change in the stop frequency (from 16 MHz to 25 MHz). This results in incorrect display of the reference trace, as this was stored with calibration in the frequency range 12 to 16 MHz.

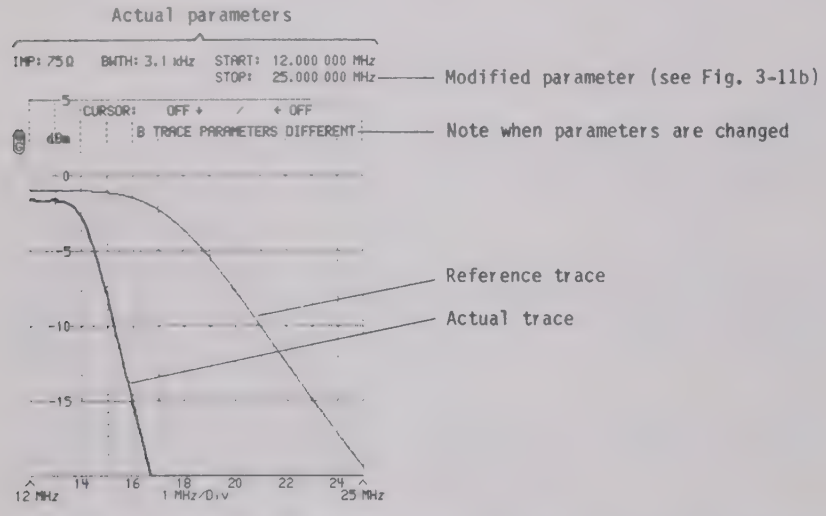


Fig. 3-12 Note when parameters of the Level Meter are changed in trace display mode "A & B" (or "A-B")

3.5.4 LEVEL DIFFERENCE "A - B"

Display of the level difference, i.e. actual trace (A) minus reference trace (B), is of considerable practical use as it permits a higher measuring and alignment accuracy to be achieved. If the intrinsic frequency response of the setup is recorded with the generator and receiver connected back-to-back before the actual measurement is carried out, and this response is stored as reference trace (B) as described in Section 3.5.2, the intrinsic error of the measuring setup can be virtually eliminated by connecting the test object into the measuring path and depressing

- key "A - B" (LED on)

This is called normalization mode. The example in Fig. 3-13 shows measurement of the frequency response of an attenuator (A-B).

---

1) Automatic range switching by depressing the key "AUTO SET" on the Level Meter operates correctly with an SG-4 connected in the Level Meters SPM-16 Series E or later and SPM-19 Series K or later.

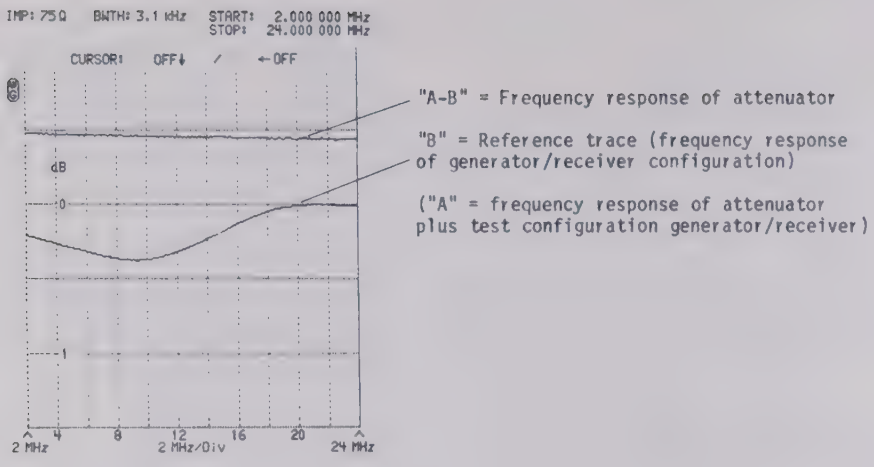


Fig. 3-13 Operating mode (A-B): frequency response of an attenuator (reference trace B displayed for comparison)

Caution: In "A-B" mode, changes of the parameters on the Level Meter result in the same notes on the screen as in "A & B" mode; see Section 3.5.3.

3.6 C U R S O R T R A N S F E R [5], [12]

The precise value of any point on the trace can be determined with the aid of the level cursor (adjusted with rocker switch [11]) and the frequency cursor (adjusted with rocker switch [4]); see Section 3.4.2 "CURSORS".

The displayed frequency value of the cursor is transferred to the SPM-16/19 as the new center frequency f'_{CENT} by depressing

- key [5]: "$f_{CENT}\rightarrow$"

The preset sweep width ΔF remains the same, but the start and stop frequencies are shifted.

The indicated level value of the cursor is transferred as a reference level to the SPM-16/19 by depressing

- key [12]: "$\overrightarrow{REF.L}$"

and is also displayed on the screen under "REF". (See also level display in SPM-16/19 after depression of key "REF" under DISPLAY [3]). The SPM-16/19 now switches from "absolute level measurement" to "differential level measurement"; the LED above the key "ABS-REF" lights. If the level cursor value is negative, the trace is moved upwards; if the level cursor value is positive, the trace is moved downwards. The measured trace can thus be moved to the required area of the screen, within the setting range of the Level Meter, with the "CURSOR TRANSFER" function.

3.6.1 EXAMPLE OF CURSOR TRANSFER

The attenuation curve of a 7 MHz low-pass filter is displayed (absolute level measurement) with the aid of the tracking generator in the SPM-16/19, which generates a constant level of approximately -19 dB at output [47].

Fig. 3-14a shows the attenuation curve ("A" key of the SG-4 depressed) within a sweep range of 2 to 13 MHz. The operator now wishes to position the stop frequency range of the low-pass filter within the screen area.

Cursor setting:

- The level cursor is set with rocker switch [11] to the pass-band of the filter (upper edge of trace ≙ -19.67 dB level line).
- The frequency cursor is positioned to the first pole (8.410 MHz); see Fig. 3-14a.

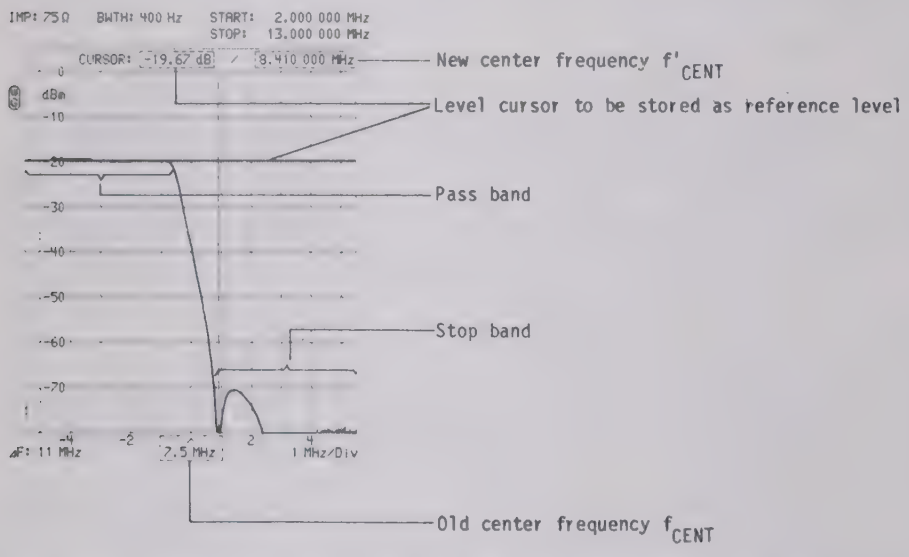


Fig. 3-14a Attenuation curve of the 7 MHz low-pass filter (input level approx. -19 dBm)

Cursor transfer:

- Depress key [4] "$\overrightarrow{f_{CENT}}$" (frequency transfer).
  The new center frequency f'_{CENT} is now 8.41 MHz.
- Depress key [13] "$\overrightarrow{REF.L.}$" (level transfer)

The trace is shifted upwards such that the level in the pass-band coincides with the 0 dB level line (differential level measurement "ABS-REF"). The (old) level cursor value is shown as the reference level on the sceeen of the SG-4 (REF: -19.67 dB). The attenuation of the first pole at 8.41 MHz can now be read from the screen: approx. -70 dB.

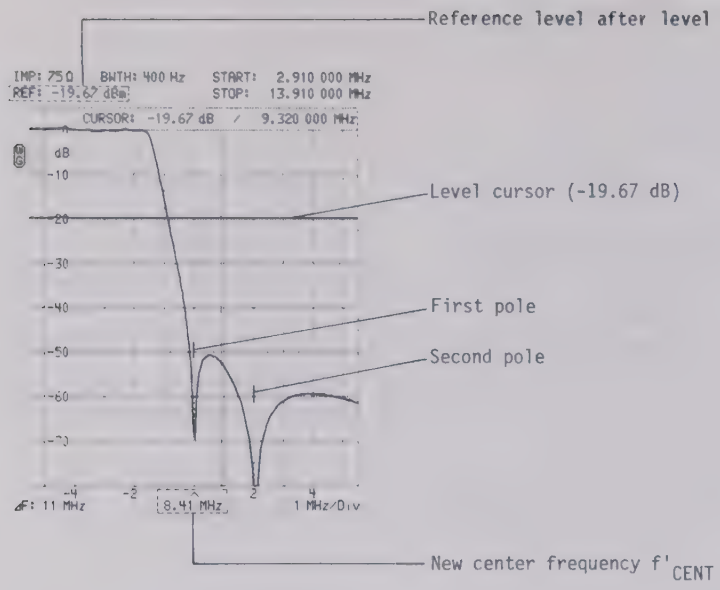
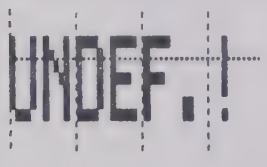


Fig. 3-14b Differential level measurement (ABS-REF): stop-band of filter moved within screen area of SG-4 by "cursor transfer"

If the transfer key [5] or [12] is depressed with the cursor switched off (level or frequency cursor set to "OFF"), the following message appears for a short time on the screen:



3.7 S P E C I A L F U N C T I O N S

3.7.1 FREEZING THE SCREEN CONTENTS "HOLD" [7]

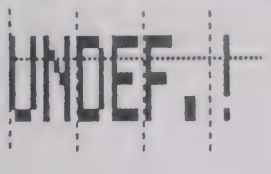
During display of the actual trace (SPM-16/19 in sweep mode "SWEEP⋀⋀", SG-4: key "A" active), the old trace is overwritten (refreshed) during each forward and backward sweep.

If the operator depresses

- key [7]: "HOLD",

recording is stopped instantaneously - red LED above key [7] blinks - and the trace currently displayed on the screen is frozen. The complete background display is also frozen, i.e. changes of parameters on the SPM-16/19 are not displayed by the SG-4 when the HOLD function is active. The complete screen contents are updated again only after the HOLD function has been switched off. We recommend that the screen contents be frozen for logging of the screen with the video plotter or the graphic plotter, particularly if the trace may be overlaid by noise signals or unpredictable interference. If the SG-4 is used together with the older Level Meters SPM-16 (up to Series C) or SPM-19 (up to Series E) and with instruments which have a volt display, then the "HOLD" key must also be depressed in order to enable the front panel controls of the Level Meter (see Section 3.1.6.1).

NOTE: If the key "MAX-HOLD" or "AVRG" is depressed while the "HOLD" function is active, the following message appears on the screen:



3.7.2 RECORDING OF MAXIMUM LEVELS - "MAX HOLD"

The MAX-HOLD function - which can be switched on with key [8] (red LED on) - has the following effects on recording of the actual trace:

During recording, a new measured value is recorded only if it is greater than the previously stored value. The trace is updated only from this time (t_o) onwards; see Fig. 3-15. In the case of varying signal levels, this makes it possible to determine the maximum level which occurred during a specific interval.

This operating mode is used for measurement of level and frequency drift of spectral lines or for detecting unwanted, sporadic excessive interference levels (long-term monitoring).

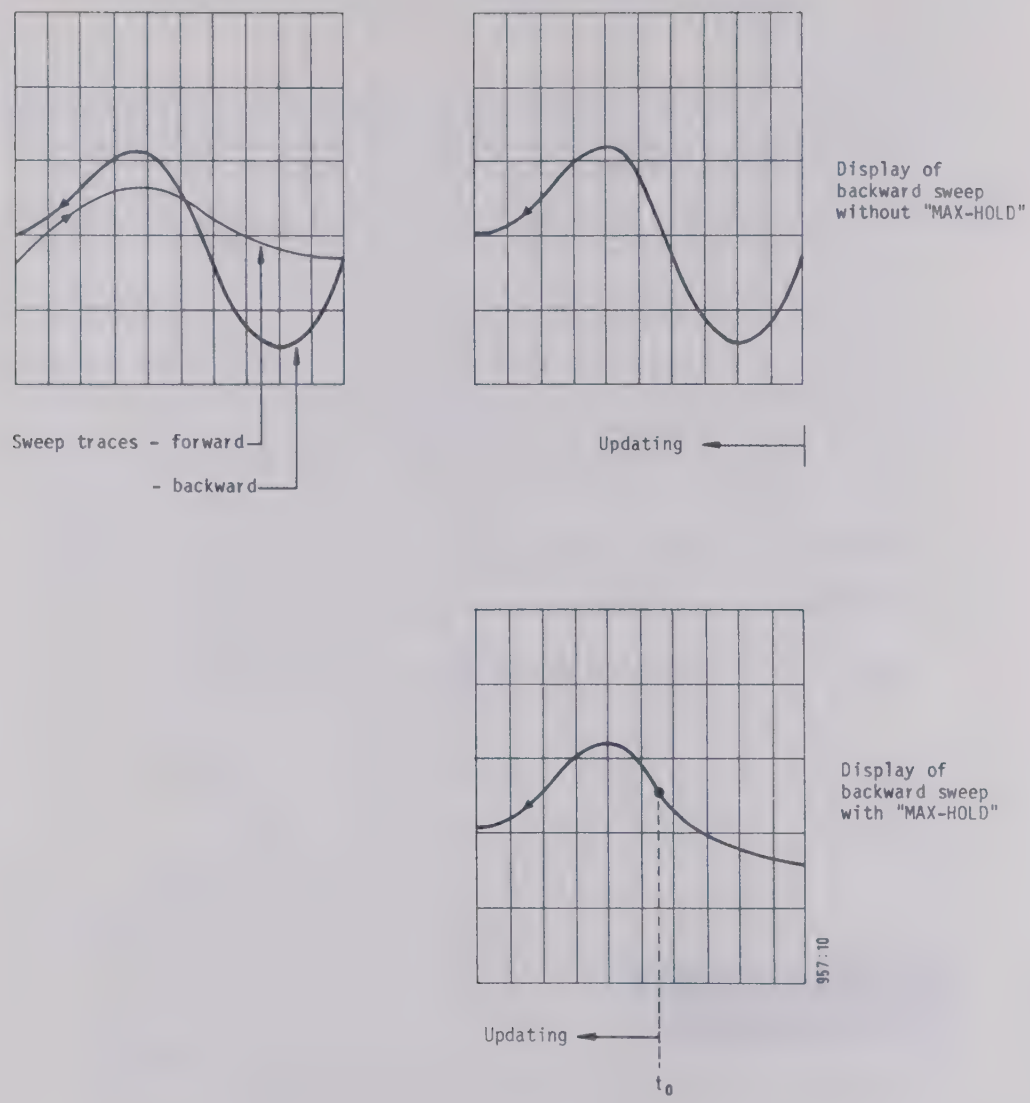


Fig. 3-15 Varying signal level: forward and backward sweeps (with long sweep duration) do not coincide; observation period: duration of the backward sweep

3.7.3 AVERAGING

Sections of a trace which, for example, have noise superimposed can be smoothed if

- key [9] "AVRG A"

is depressed (red LED on).

Before switching on the averaging function, wait for one complete forward and backward sweep to be executed in order to avoid excessive settling times during averaging. After "AVRG A" has been depressed, do not change settings on the Level Meter[1)].

Averaging is carried out successively, and maximum averaging of the displayed trace is achieved only after 6 complete sweep cycles.

The averaged sweep signal in the example in Fig. 3-16 appears as a "noise band", as the maximum and minimum values are averaged separately; see also Section 2.

Advantage: Signals in the same order of magnitude as the noise level are clearly detected; see Fig. 3-16. In addition, in contrast to the meter indication "slow" on the Level Meter (key [11] "AVRG" depressed), it is not necessary to reduce the sweep rate.

The following information appears on the screen when averaging is switched on (SG-4, SPM-16/19):

a) DIG AVRG — Digital display averaging by SG-4

b) SPM AVRG — Meter display "slow" by SPM-16/19

c) AVRG — Averaging by SG-4 and SPM-16/19, a) and b) together.

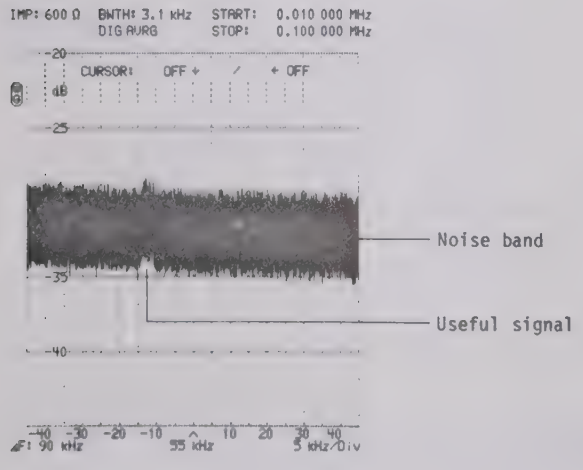


Fig. 3-16 Useful signal made visible by averaging

1) key [11] "AVRG" may be switched on.

3.8 TOLERANCE MASKS

3.8.1 GENERAL

With the aid of tolerance masks, it is easy to detect whether traces lie within specific level limits. The SG-4 permits display and storage of two independent tolerance limits (M1 and M2), which can consist of several straight lines at any required angle. In addition, several tolerance masks can be stored in the memory (see Section 3.8.4). Fig. 3-17 shows an example of a tolerance mask which consists of a total of 10 points. A total of 32 points can be defined, these being split as required between tolerance limits M1 and M2.

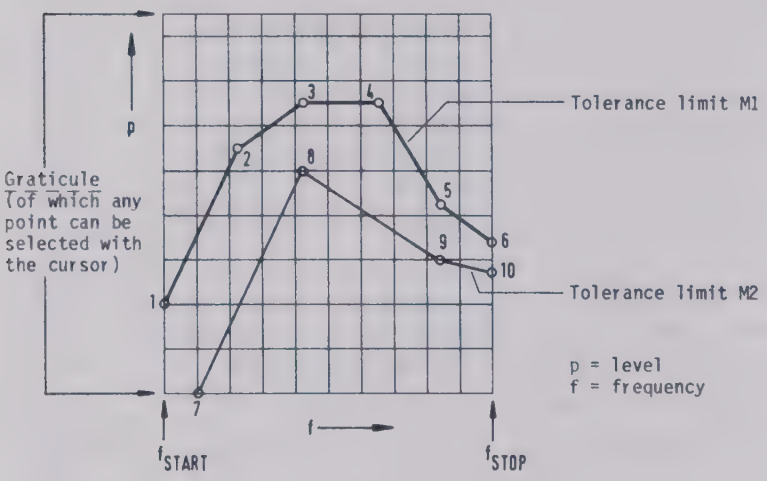


Fig. 3-17 Tolerance mask consisting of mask points (p_i/f_i), i = 1 to 10

Tolerance limits (or mask points) exist either as a table (p_i/f_i) or in the form of a diagram. Input of the points into the SG-4 is carried out with the cursor and the soft keys.

3.8.2 PROGRAMMING A TOLERANCE MASK

- Depress key [2] "SCALE MENU" (LED on)
  Monitor display "scale menu 1" appears as shown in Fig. 3-8.
- Depress soft key "PRGM MASK" (see function in Table 3-4)
  Monitor display "scale menu 2" appears as shown in Fig. 3-18; the functions of the soft keys (with abbreviations on right end of screen) are explained in Table 3-5.

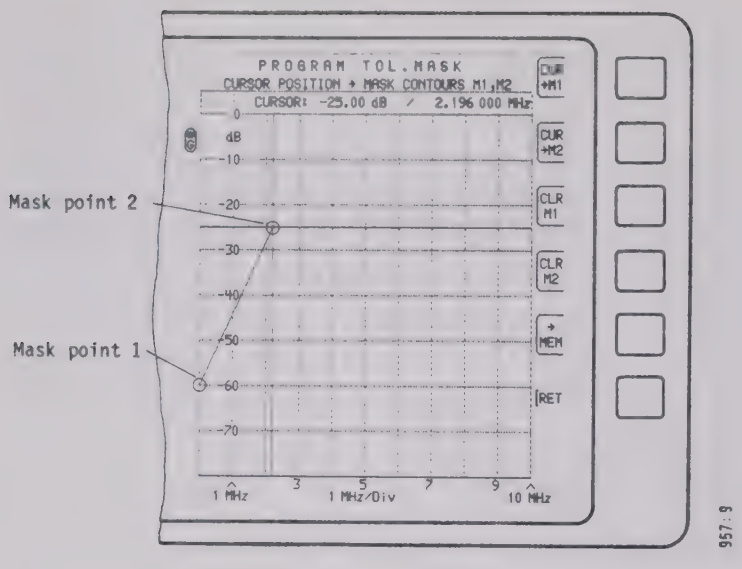


Fig. 3-18 Monitor display "scale menu 2" (programming of tolerance masks)

Programming of tolerance limits M1, M2

- Move the level cursor (with key [11]) and frequency cursor (with key [4]) to the first mask point of tolerance limit M1 (e.g. -60 dB/0.1 MHz, see Fig. 3-18).
- Depress soft key "CUR→M1" (first mask point is stored).
- Set the cursor to the second mask point of M1 (e.g. -25 dB/2.2 MHz; see Fig. 3-18)[1].
- Depress soft key "CUR→M1" (straight line is displayed).

  Further mask points are entered as described above. It is also possible to define the first mask point (shown on the left of the screen in the example) on the right edge of the screen. Programming of the tolerance limit M1 by assembling straight lines with any required angles is then carried out in the reverse order.
- Programming of the mask points of tolerance limit M2 is carried out with the cursor and by depressing soft key "CUR→M2".
  After input of a total of 32 mask points for M1 and M2, input of a further mask point will not result in display of the last straight line (memory for tolerance mask full).

Clearing of the tolerance mask

- If a point is entered incorrectly during programming, the last point of M1 which was entered can be erased by depressing soft key "CLR M1". If soft key "CLR M1" is depressed again, the last mask point but one of M1 is erased, etc.
- Similarly, mask points of tolerance limit M2 can be erased with soft key "CLR M2"
- If all mask points are erased with soft keys "CLR M1" and "CLR M2", the following note appears on the screen:

MASK CLEARED

1) Due to the resolution of the frequency scale, it is not possible to set the cursor to 2.2 MHz. The closest value is therefore used; see value of frequency cursor in Fig. 3-18.

After input of the tolerance mask, depress

- key [2] "SCALE MENU" (SCALE MENU is switched off, LED [2] is off).

The screen graticule with the actual trace (as selected by key function [3]) and the tolerance mask is displayed if soft key function "TOL. MASK" of scale menu 1 as shown in Fig. 3-8 is active (ON).

Soft key name	Function
CUR →M1	Depression of this key causes the intersection of the level and frequency cursors to be stored as a mask point for tolerance limit M1. The straight line to the previously entered mask point (M1) is displayed.
CUR →M2	Depression of this key causes the intersection of the level and frequency cursors to be stored as a mask point for tolerance limit M2. The straight line to the previously entered mask point (M2) is displayed.
CLR M1	Depression of this key deletes the previously entered mask point for tolerance limit M1. The corresponding straight line is deleted. The tolerance limit M1 can be deleted step by step by further depression of this key.
CLR M2	Depression of this key causes the last mask point entered for tolerance limit M2 to be deleted. The corresponding straight line is deleted. Further depression of this key permits the tolerance limit M2 to be deleted step by step.
→ MEM	Depression of this key causes the mask to be stored in the address range 100 to 110 if the SPM-16/19 is in "memory mode".
RET	Depression of this key switches on the monitor display as shown in Fig. 3-8.

Table 3-5 Soft key functions for monitor display "tolerance mask programming" as shown in Fig. 3-18

3.8.3 SWITCHING OFF THE GRATICULE

A measured trace can be displayed without the graticule (background display) and with only the previously entered tolerance mask as a reference value. Depression of the soft key "RAST" (see Fig. 3-8) switches off the background display. If the cursor lines are not required, they can be shifted over the edge of the screen as previously described (rocker switches [4] and [11]). The display "OFF ↓ ,←—OFF" can be switched off by depressing the key "A". The actual trace and the tolerance mask are displayed on the screen as shown in the example in Fig. 3-19 (providing soft key "TOL MASK " is in the position "ON").

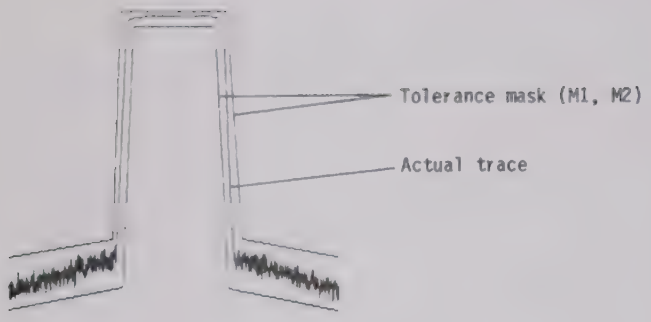


Fig. 3-19 Actual trace with tolerance mask (background display switched off)

3.8.4 STORING SEVERAL TOLERANCE MASKS

Further tolerance masks can be stored in the address range 100 to 110 with the memory function of the SPM-16/19 (blue key "MEM" [6] on). This results in the same address allocations for the tolerance masks as for the corresponding setups of the SPM-16/19. However, the tolerance masks themselves are stored in the Display Unit. A total of approximately 150 memory positions is available for the various mask points for display of the tolerance masks.

3.8.4.1 Storing a tolerance mask

● SPM-16/19 settings: Store front panel setup

- Depress key [6] "MEM" (LED on)[1)]
- Select the address - e.g. 105 - and enter it ("MEM" LED blinks)
- Depress key "STO" ("MEM" LED is extinguished)
- Depress key [6] "MEM" again (LED on)[2)]

● SG-4 settings:

- Depress key [2] "SCALE MENU" (LED on): "scale menu 1" appears as shown in Fig. 3-8.
- Depress soft key "PRGM MASK": "scale menu 2" appears as shown in Fig. 3-18.
- Enter the tolerance mask with the cursor and the soft keys (CUR→M1, CUR→M2, (CLR M1, CLR M2)) as described in Section 3.8.2.
- Depress soft key "→MEM".
- The tolerance mask is assigned to the current address. Note appears on the screen, e.g.:

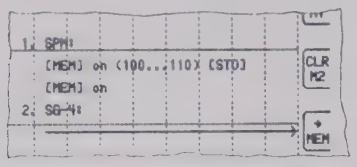
MASK IN MEM No 105

1) With SPM-16, Series C and D, SPM-19, Series C to E, first depress key "HOLD" on SG-4 (red LED on).

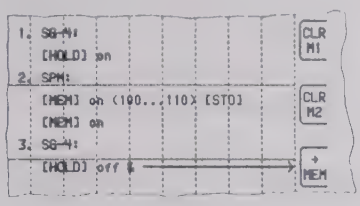
2) With SPM-16, Series C and D, SPM-19, Series C to E, first depress key "HOLD" (red LED is off).

- If, instead of the previous note (confirmation that the displayed tolerance mask is stored under address 105), the information appears as in b[1], then an operator's error has occurred. The information contains the correct operating sequence, which acts as a reminder.

a



b[1]



- Further tolerance masks can, after input (in accordance with Section 3.8.2), be stored for the corresponding setups with the soft key function "→MEM".

  If the tolerance mask memory of the display unit becomes full, i.e. after input of more than 150 mask points, the following note appears on the screen:

MASK MEMORY OVERFLOW

3.8.4.2 Recalling a stored tolerance mask

● SPM-16/19 settings:

- Depress key [6] "MEM" (LED on)[2]
- Enter address number under which the required setup and tolerance mask (in SG-4) are stored.
- Depress key "RCL".

● SG-4 settings:

- If necessary, switch on the tolerance mask with "scale menu 1" as shown in Fig. 3-8 (soft key "TOL MASK").
  The current tolerance mask is displayed on the screen together with the parameters of the SPM-16/19.

NOTE: To switch the stored mask on and off, it is sufficient to depress the soft key "TOL MASK" without displaying "scale menu 1" beforehand.

3.9 DOCUMENTATION OF RESULTS

3.9.1 VIDEO OUTPUT

The monitor of the SG-4, which operates on the video principle, provides the composite video (BAS) signal at BNC connector H (see Fig. 3-7) on the rear of the instrument for further processing. This makes it possible to display a large picture on an external monitor or to print the screen contents with the aid of a video printer. The video printout, which contains all important parameters for the traces, is an efficient and error-free record of the results.

The BAS signal is continuously available at output H; recording of the results is initiated on the video printer.

---

1) Operating Manual with SPM-16, Series C and D, SPM-19, Series C to E.

2) With SPM-16, Series C and D, SPM-19, Series C to E, previously depress key "HOLD" on SG-4 (red LED on).

The screen display must remain static for the duration of the recording operation. We therefore recommend that the screen contents be frozen with the "HOLD" function before starting the printer. If the moving record marker (see Section 3.5.1) interferes with the printer operation, then it should be stopped by depressing the "f" key on the Level Meter.

If the connected video printer does not reproduce the background display, or reproduces it with insufficient clarity, the intensity of the text and graticule lines should be increased slightly with potentiometer M (see Fig. 3-7) on the rear of the SG-4, such that it exceeds the threshold of the printer.

For complete reproduction of the screen information, it may be necessary to correct the settings of the video printer or large screen monitor.

3.9.2 CONNECTION OF THE GRAPHIC PLOTTER (e.g. HP 7470 A)

A Hewlett & Packard graphic plotter (e.g. Type 7470 A) can be connected via the IEC/IEEE bus for recording of the screen contents; see Fig. 3-20. The SG-4, in its controller function (address switch "SC" to the left (on)), controls the graphic plotter. For this purpose, depress key [2] SCALE MENU (LED [2] on); "scale menu 1" as shown in Fig. 3-8 appears.

Depression of soft key "GRPH PLOT" to the position "RUN" causes the complete screen contents to be recorded by the graphic plotter (see also Table 3-4).

In order to provide clear results, actual trace A and the cursor lines are recorded in a different color from that used for the background display, providing the graphic plotter has two pens of different colors. The complete recording requires approx. 3 mins.

Recording can be stopped at any required position by again depressing the soft key "GRPH. PLOT" ("STOP" position).

If the graphic plotter is to record only the actual trace or is to record a second actual trace in previously recorded screen display (actual trace plus background), then the background display can be switched off with the soft key "RAST" (OFF). Recording of the actual trace is then again started with soft key "GRPH. PLOT" (to RUN).

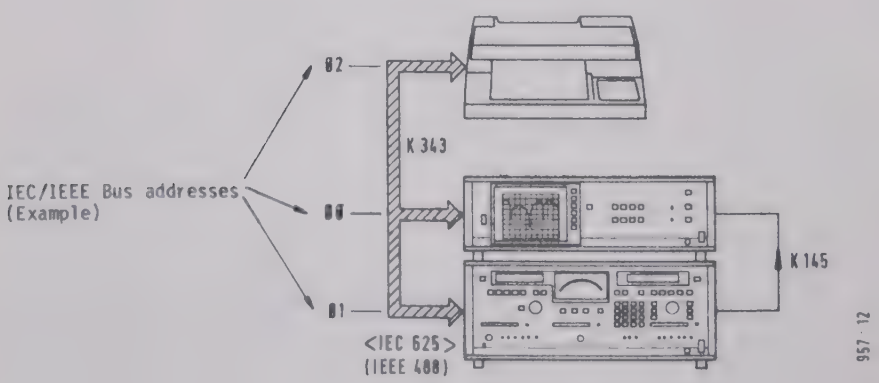


Fig. 3-20 Graphic plotter operation via IEC/IEEE bus

NOTE: The address of the graphic plotter must be set such that it is two higher than the address of the SG-4 (or one higher than the address of the SPM-16/-19).

3.9.3 CAMERA MOUNTING FRAME FVR 8

The special camera B-20 produced by Messrs. "Shackman" is recommended for rapid documentation of the screen contents. In order to simplify mounting, Wandel & Goltermann offers a suitable camera mounting frame as an accessory, which is attached to the mask of the screen;
Order No.: 980/00.01.

3.10 C O M P U T E R C O N T R O L <IEC 625>/IEEE 488 Bus

3.10.1 GENERAL

All functions initated by depressed keys (included soft key functions) may be remote controlled by a computer via the IEC/IEEE Bus. Or the curves displayed on the CRT may be read into the Bus and further processed externally.

The switch element "SC" of the address switch (see Fig. 3-4) is therefore switched to OFF. The address of the SG-4 (always "1" smaller than the address of the SPM-16/19) as well as the parallel-poll switch (see Fig. 5-3) is reset if necessary or should be adapted to the Bus System already present.

Implemented <IEC 625> Interface Functions

In accordance with the <IEC 625> Standard the following commands are realized for the SG-4 by means of the interface functions at the <IEC 625> Interface.

SH1	Source Handshake - full configuration
AH1	Acceptor Handshake - full configuration
T6	Talker - all functions
L4	Listener
SR1	Service Request
PP2	Parallel Poll - established by a switch
DC1	Device Clear - full configuration
DT1	Device Trigger - full configuration
C1 to C5	Controller function
RL1	Remark/Load function - full configuration

3.10.2 PROGRAMMING

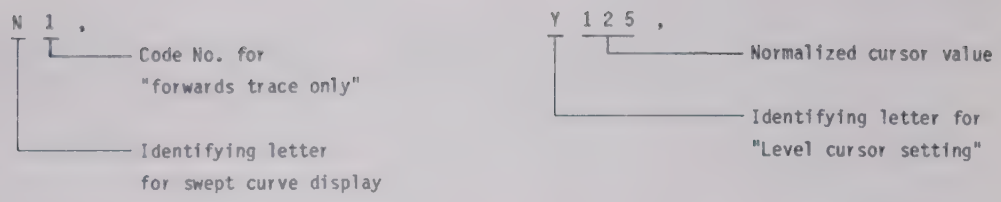
3.10.2.1 General information for programming[1)]

The data exchange between the SG-4 and the external control unit (or between the SG-4 and the SPM-16/19 and perhaps a video plotter) takes place as described below.

Setting-up the SG-4 (e.g. superimpose sweep curve A, switch on display averaging, establish cursor lines and so on) is done by a data set (Programming Data) that is transferred to the SG-4 from the control unit. The data set usually comprises an identifying letter following by a code number or parameter field like e.g.:

---

1) Knowledge of the remote control operation of the SPM-16/19 is a prerequisite;
Order No. 2755 (English)



The data set is either terminated or separated by a comma. After transfer of the Controller Function to the SG-4 (see Para. 3.10.2.2) the Display Unit can be triggered by the "Device Trigger" and then set-up for measuring, or a result curve can be transferred to the computer. If the function is terminated, then the SG-4 annunciates with "Service Request" if so programmed, or the computer interrogates the status byte until it recognizes that the setting is terminated.

In case of an "erroneous measurement" the so-called "Error Message" furnishes more information, when corresponding commands have been programmed.

3.10.2.2 Interrupt program for basic set-up of SG-4 (Controller Function)

In order that a smoothly interacting operation of the system, "SG-4, SPM-16/19 and Computer" may be assured, the program must run through a subroutine before the processing of the actual control information takes place. This is when the SG-4 is defined as "System Controller".

The parameters for the internal graticule (scale range, measuring range, f_{START}, f_{STOP}) are thereby automatically taken over (in a manner analogous to LOCAL mode). In order to transfer the "System Control" function, the SG-4's status byte is interrogated in the so-called "Interrupt Program SRQ" (see 3.10.2.3) and the bit positions "2 and 3" are evaluated.

Figure 3-20 illustrates the sequencing of a program with the "Interrupt Program SRQ" that must be contained in every SG-4 remote control program.

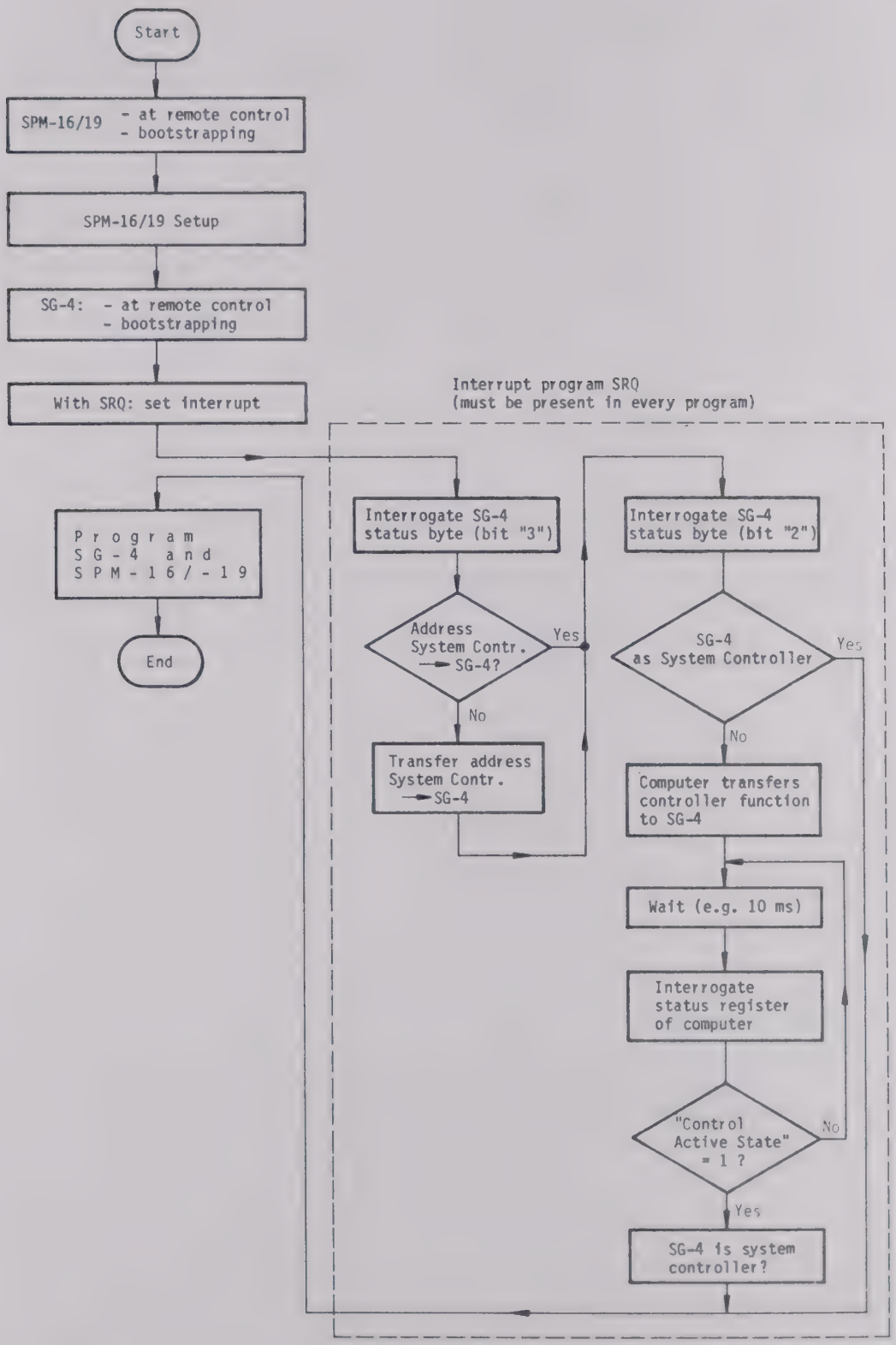


Fig. 3-21 Flow chart for SG-4 under remote control

3.10.2.3 Status Information

In answer to a "Serial Poll" sequence, the SG-4 transfer a status byte to the computer (Fig. 3-22).

In positions 0 to 7 a "1" signifies:

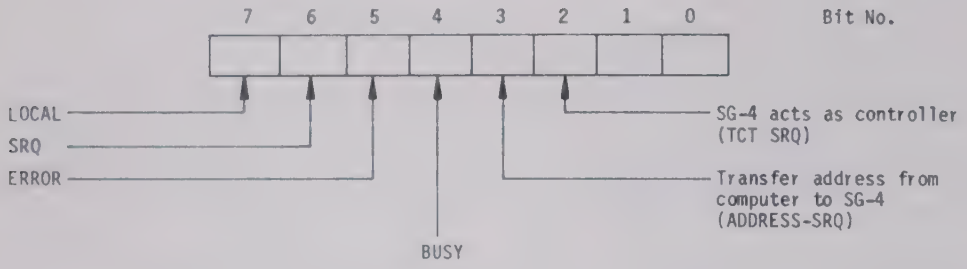


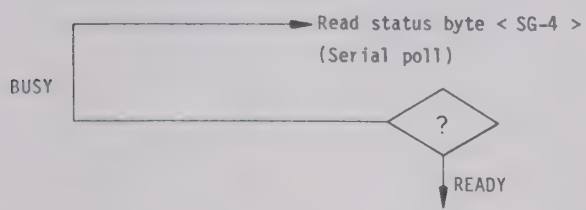
Fig. 3-22 Status byte

3.10.2.4 Post-conditions with SG-4 program commands

Information regarding a post-condition for the programming words in para. 3.10.5: after the transmission of the programming word (OUTPUT command) an interrogation of the status bit "4" (BUSY) takes place according to the following plan:

SG-4 command [BØ,] e.g. display trace A

TRIGGER < SG-4 >



3.10.3 INITIALIZATION

After an <IEC 625> Bus Command "Device Clear", and in the event, "Interface Clear" at the SG-4, the operating status is set-up as if the following program words had been received from the control terminal (after sequencing of the "Interrupt Program SRQ"):

AØ	No display averaging
BØ	A curve
DAMINØØØØØ1	1st value of A curve (Y_{min})
EØ	Absolute scale calibration
HØ	HOLD function "off"
J1	Automatic cursor transfer function
K1	Soft-key display "on"
LØ	Tolerance mask display "off"
NØ	Display of forwards and backwards trace
TØ	Trigger mode "continuous trigger"
X9	X cursor "off"
Y9	Y cursor "off"
XXØØØ11	Interface mode
YYØ31313131	Control Mode[1)]

3.10.4 PROGRAMMING EXAMPLE (FOR HP-85 DESKTOP COMPUTER)

3.10.4.1 Interrupt program

The following example illustrates a possibility of using the "Interrupt Program" for the HP-85 Desktop Computer. The program listed here is likewise used in the following programming examples.

---

1) See para 3.10.7

Interface select code	No. 7
Address SG-4	0
Address SPM-19	1

```
10 DISP "PROG. EXAMPLE SG4"
20 !
30 RESET 7
40 REMOTE 701
50 CLEAR 701
60 !
70 ! SETUP OF THE SPM
80 OUTPUT 701 ;"H10000000.0,W00
   010000.0,R060,S55,"
90 TRIGGER 701
100 REMOTE 700
110 CLEAR 700
120 ON INTR 7 GOSUB 210
130 ENABLE INTR 7;8
140 !  PROG. SG4 AND SPM
150 !
160 GOTO 160 ! END
170 !
180 ! ************************
190 ! ************************
200 !
210 ! ----------UP--------------
220 !   SG4-SPM-HP85
230 ! INTERRUPT-PROG. "SRQ"
240 ! -------------------------
250 !
260 STATUS 7,1 ; A
270 !
280 S=SPOLL(700)
290 ! REQUEST CONTROLLER FUNC.
300 IF BIT(S,2)=1 THEN GOSUB 500
310 !  ADDRESS-SRQ ?
320 IF BIT(S,3)=1 THEN GOSUB 380
330 ENABLE INTR 7;8
340 RETURN
350 !
360 ! -------------------------
370 !
380 ! UP : SYSTEM-CONTROLLER-
390 !      ADDRESS --> SG4
400 !
410 OUTPUT 700 ;"T1,K0,YY121,"
420 TRIGGER 700
430 DISP "ADDRESS --> SG4"
440 GOSUB 630
450 OUTPUT 700 ;"T0,"
460 RETURN
470 !
480 ! -------------------------
490 !
500 ! UP : PASS CONTROL
510 !
520 DISP "PASS CONTROL TO SG4"
530 PASS CONTROL 700
540 !
550 WAIT 10
560 STATUS 7,5 ; A
570 IF BIT(A,5)=0 THEN 550
580 DISP "ACTIVE CONTROL"
590 RETURN
```

} SPM-19 switched to remote control and bootstrapping

} SPM-19 set-up: f_{CENT} = 10 MHz, Δf = 10 kHz, 80 dB scale, SWEEP $\wedge\wedge$, bandwidth 3.1 kHz

} SG-4 switched to remote control and bootstrapping

} Interrupt with SRQ (jump towards 210)

} Program SG-4 (SPM-16/-19)

Program lines 210 to 750 "Interrupt Program SRQ"

} Serial poll interrogation of status bits "2" and "3" with branching

} 330: Interrupt with SRQ 340: Jump back to main program

SRQ for requesting the Controller Function,
Transfer address

} 440: Jump to Statement 630
450: Trigger mode "Continuous trigger" 460: Jump back to Statement 330

Transfer "System Control" function to SG-4

Wait 10 ms

} Interrogation of status bit "Control Active State" in a loop (Register SR5)

590: Jump back to Statement 310

```
600 !
610 ! -------------------------
620 !
630 ! UP : BUSY
640 DISP "BUSY"
650 WAIT 10                                  }
660 S=SPOLL(700)                             }
670 IF BIT(S,2)=1 THEN GOSUB 500             } Serial poll interrogation of status bits "2" and
680 S=SPOLL(700)                             }
690 IF BIT(S,4)=1 THEN 650                   } "4" with branching
700 DISP "READY"                             }
710 RETURN                                   Jump back to statement 450
720 !
730 ! -------------------------
740 !
750 END
```

The processing of the interrupt program is alternately signalled in the monitor by the printout "PASS CONTROL TO SG-4" and "ACTIVE CONTROL". After this sequence has run-off and after the setting-up of the SPM-19, the "READY" message appears.

The SG-4 can be controlled from the computer.

Example: Store the current curve A as reference curve

Key in the following statements:

```
OUTPUT 700 ; "S,"          Programming word "S,"[1)]
OUTPUT 700 ; "B1,"         Programming word "B1,"[2)]
```

3.10.4.2 Cursor setting (X,Y)

In order that cursor settings or tolerance mask superpositions may be accomplished, the actual internal graticule, i.e. level values and frequency values, each according to the selected setup of the Level Meter, must be referred to the definition range of the x and y values. Fig. 3-23 shows an example with the relationship for normalization.

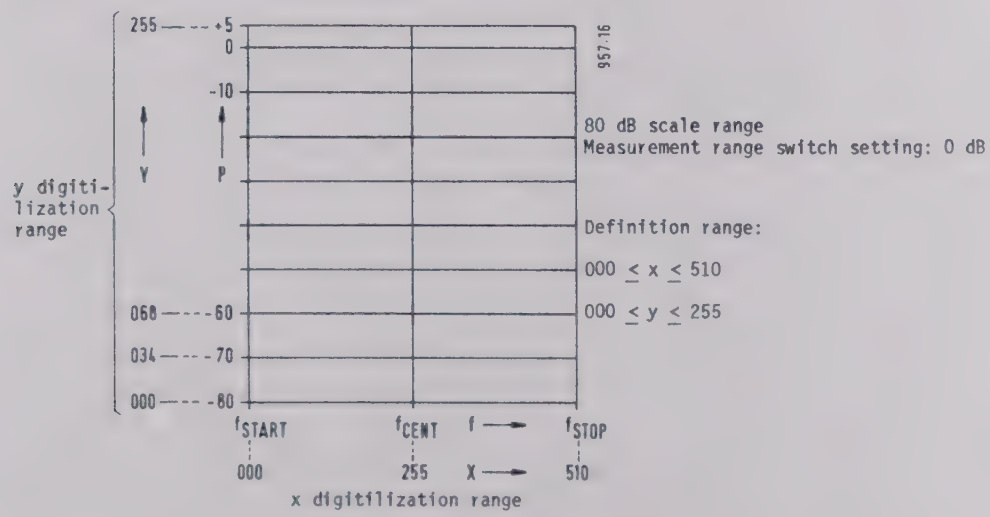


Fig. 3-23 80 dB internal graticule of the SG-4 with the normalized digital values of x and y

1) Corresponds to key function "STORE A→B"

2) Corresponds to key function "B"

From Fig. 3-23, the following relationships for x and y can be obtained

$$x = 510 \cdot \left[\frac{f - f_{START}}{f_{STOP} - f_{START}} \right] \qquad y = 255 \cdot \left[\frac{P(dB) + 80\ dB}{85\ dB} \right]$$

taking into account measuring range M:

$$y = 3 \cdot [p(dB) + 80\ dB + M]$$

In the example of the SPM-19 set-up according to para. 3.10.4.1:

f_{CENT} = 10 MHz, Δf = 10 kHz

the frequency cursor shall be located at 9.998920 kHz and the level cursor at -47 dBm. With the above relationship, it follows that:

x = 200 y = 100

After the interrupt program has run-off, the following statement can be entered:

```
OUTPUT 700 ; "X200,Y100,"
```

3.10.4.3 Cursor - Transfer (F, R,)

The following program shows a frequency and cursor transfer by use of the example for the set-up according to para. 3.10.4.1.

Therefore, certain preconditions must be adhered to:

BØ or B2	:	Curve A or A&B
HØ	:	"HOLD" function off
KØ	:	Soft key function off
Implement cursor setting		
J1	:	Auto transfer
T1	:	Trigger mode, once

```
 10 DISP "PROG. CURSOR TRANSF "
 20 !
 30 RESET 7                                  } SPM-19 at remote control and initialization
 40 REMOTE 701                               }
 50 CLEAR 701                                }
 60 !
 70 ! SETUP OF THE SPM                       }
 80 OUTPUT 701 ;"H10000000.0,W00             } SPM-19 set-up: f_CENT = 10 MHz, Δf = 10 kHz,
    010000.0,R060,S55,"                      } 80 dB scale, SWEEP /\/\
 90 TRIGGER 701                              }
100 !
110 !
120 REMOTE 700                               } SG-4 at remote control and initialization
130 CLEAR 700                                }
140 ON INTR 7 GOSUB 510                      } Interrupt with SRQ (jump into interrupt program)
150 ENABLE INTR 7;8                          }
160 !
170 ! -- PROG. SG4 -------
180 ! Setup of the Cursor                    Cursor setting
190 OUTPUT 700 ;"X200,Y100,"                 Trigger release in subroutine
200 GOSUB 310
210 !
220 ! Preconditions:                         Preconditions
230 OUTPUT 700 ;"H0,K0,J1,T1,"               Trigger release in subroutine
240 GOSUB 310
250 !
260 ! Transfer                               Cursor transfer
270 OUTPUT 700 ;"F,R,"                       Trigger release in subroutine
280 GOSUB 310
290 GOTO 370
300 !
310 ! --SUB --
320 TRIGGER 700                              }
330 WAIT 10                                  } Monitor triggers and status bit "BUSY"
340 S=SPOLL(700)                             }
350 IF BIT(S,4)=1 THEN 330                   }
360 RETURN                                   Jump back to statements 210, 250, and 290
370 !
380 GOTO 380 ! END
390                                          }
 .                                           }
 .                                           }
 .                                           } Interrupt program according to para. 3.10.1
 .                                           }
 .                                           }
```

3.10.4.4 Tolerance mask programming (M)

A tolerance mask may be programmed by combining the paired values of the mask points (X_i/Y_i so that a string is formed and transferred to the SG-4 by an OUTPUT command.

The programming word or the configuration of the outputted string is to be taken from para. 3.10.5.

Before the M1 string or M2 string are to be transferred, the following conditions must be adhered to:

- maximum 32 points (for M1 and M2) are programmable
- definition range for X : ØØØ $\leq$ X $\leq$ 510
  definition range for Y : ØØØ $\leq$ Y $\leq$ 255

Moreover, the following preconditions must be switched on:

- TØ Trigger mode "continuous"
  KØ Soft key function "off"
  XØ X cursor "on"
  YØ Y cursor "on"
  L2 Mask programming "on"

Example: in the internal graticule of the example according to para. 3.10.4.1, a straight line shall be traced between points (9.995 MHz/-80 dB) and (9.998 MHz/-47 dB).
The normalized value is equal to (Ø / Ø) und (2ØØ / 1ØØ)

x_1 y_1 x_2 y_2

After the interrupt program of para. 3.10.4.1 has been run-off the following statements should be entered:

```
OUTPUT 700 ; "X0.Y0,L2,"          Preconditions
OUTPUT 700 ; "M1000000200100,"    M1 string sent
```

If the last mask point (X_2/Y_2) is to be deleted, the the following statement should be entered:

```
OUTPUT 700 ; "C1,"
```

So that a tolerance mask, comprising many points (≤ 32), may be entered via a computer, the selected internal graticule (SPM-19 set-up) should be configured in the program after recalculation to the normalized x and y values.

The following program is applicable to the previously used internal graticule:

```
 10 DISP "PROG. EXAMPLE SG-4"
 20 ! Programming a Tolerance ma
    sk
 30 !
 40 DIM F(10),P(5),X$[3],Y$[3],A
    (32),M$[100],M1$[100],M2$[10
    0]                            Reserve storage area
 50 !
 60 RESET 7                       }
 70 REMOTE 701                    } SPM-19 at remote control and initialization
 80 CLEAR 701                     }
 90 !
100 ! SETUP OF THE SPM
110 OUTPUT 701 ;"H10000000.0,W00  }
    010000.0,R060,S55,"           } SPM-19 set-up: 80 dB scale, f_CENT = 10 MHz
120 TRIGGER 701                   } Δf = 10 kHz, SWEEP
130 REMOTE 700                    } SG-4 at remote control and initialization
140 CLEAR 700                     }
150 ON INTR 7 GOSUB 1030          }
160 ENABLE INTR 7;8               } Interrupt with SRQ (jump to Int. Prog.)
170 WAIT 200
180 DISP "Numbers of mask points
     M1 ?"
190 INPUT A                       Enter number of mask points for M1
200 M1$=""                        200: Initialize M1$      220: Establish M1 loop
210 I=A
220 GOSUB 440
230 !
240 M1$=M1$&X$&Y$.                Form M1$
250 !
260 I=I-1                         }
270 IF I=0 THEN 290               } Process loop
280 GOTO 220                      }
290 DISP "M1 entered !"
300 DISP "Numbers of mask points
     M2 ?"
310 INPUT B                       Enter number of mask points
320 M2$=""                        320: Establish string    330/340: Initialize
330 X$=""                             variables for M2             X$, Y$
340 Y$=""
350 J=B                           350: Establish loop      370: Form M2$
360 GOSUB 440                         for M2
370 M2$=M2$&X$&Y$
380 J=J-1                         }
390 IF J=0 THEN 420               } Process loop
400 GOTO 360                      }
410 !
420 DISP "M2 entered !"
430 GOTO 700
440 DISP "f in MHz"               Enter frequency in MHz!
450 !
460 INPUT F
470 !
480 X=510*(F-9.995)/.01           Calculate X value (see formula in para. 3.10.3.2)
490 X=INT(X)
500 IF X<10 THEN 560              }
510 IF X<100 THEN 540             }
520 X$=VAL$(X)                    } Form 3 position X string
530 GOTO 570                      }
540 X$="0"&VAL$(X)                }
550 GOTO 570                      }
```

```
560 X$="00"&VAL$(X).
570 DISP X$
580 DISP "P in dB"                          Enter level in dB
590 INPUT P
600 Y=(P+80)*3                              Calculate Y value (see Formula in Section 3.10.4.2)
610 IF Y<10 THEN 670
620 IF Y<100 THEN 650
630 Y$=VAL$(Y)
640 GOTO 680                                Form 3 position Y string
650 Y$="0"&VAL$(Y)
660 GOTO 680
670 Y$="00"&VAL$(Y)
680 DISP Y$
690 RETURN
700 OUTPUT 700 ;"T0,K0,X0,Y0,L2,            Establish preconditions
    "
710 TRIGGER 700
720 OUTPUT 700 ;"M1"&M1$&","
730 TRIGGER 700                             Send masks M1 and M2
740 OUTPUT 700 ;"M2"&M2$&","
750 TRIGGER 700
760 !
770 GOTO 770 ! END
780 "Interrupt program"                     Use interrupt program according to para. 3.10.4.1
```

Run-off of program

After the interrupt program has been processed, mask M1 should be entered: number of points, frequency entry in MHz, level entry in dB. Then, in an analogous manner, mask M2 is entered.

Storage of tolerance mask via SPM-16/-19 memory function

In a manner similar to the manual operation of the SG-4, a tolerance mask that has already been entered for a related setup can be stored in address area 100 to 110 of the Level meter. With that, when the SPM-16/-19 is set-up, the memory function is switched on. The information in line 110 of the program example must accordingly be supplemented.[1)]

```
110 OUTPUT 701 ;"H10000000.0,W00
010000 0,R060,S55,A20101,"
```

Address "101"
STO command
MEM function

1) See SPM-16/-19 programming manual for programming word for MEM and STORE function

3.10.4.5 B curve plotting (G)

As reference curve a freely defined (or mathematical) curve can be arranged by the computer. The (G) command (see programming word in para. 3.10.5) is used to write a string with a character length of 3 x 510 (510 y values) into the B curve store of the SG-4.

Likewise, curves that resulted from previous measurements and were stored on magnetic tape in a cassette can be loaded into the B curve store at a later time.

The programming example shows the writing-in of a theoretical attenuation curve (Butterworth low-pass filter of 5th degree) in frequency range 0.1 to 5.2 MHz.

The magnitude of the attenuation function of the Butterworth low-pass filter of the 5th degree is:

$$|D(\Omega)| = \sqrt{1 + \Omega^{10}}$$

Ω = normalized circuit frequency
Ω = 1: 3 dB cut-off frequency

Frequency transformation:

From the relationship for the normalized frequency x (according to 3.10.4.2) it follows that for the given frequency range:

$$x = 510 \cdot \left[\frac{f - 0.1\ \text{MHz}}{5.2\ \text{MHz} - 0.1\ \text{MHz}}\right]$$

Let the 3 dB cut-off frequency be 1 MHz, therefore: $\Omega = f \cdot 1\ \text{MHz}$

From the above relationship: $\Omega = 0.01x + 0.1$

The attenuation is:

$$a = 20 \log |D(x)| = 20 \log \sqrt{1 + (0.01x + 0.1)^{10}} \quad \text{[in dB]}$$

The attenuation curve shall be displayed in the 80 dB scale range. The programming example can be applied for other filter curves when a corresponding frequency transformation is accomplished and the formula for the attenuation is formed accordingly.

Program duration about 2 min!

```
10 DISP "PROG. EXAMPLE SG-4"
20 !
30 RESET 7
40 REMOTE 701                          } SPM-19 at remote control and initialization
50 CLEAR 701                           }
60 !
70 ! SETUP OF THE SPM                  }
80 OUTPUT 701 ;"U000100000,V005        } SPM-19 set-up: f START = 0.1 MHz,
   200000,R060,"                       } f STOP = 5.2 MHz, 80 dB scale
90 TRIGGER 701                         }
100 !
110 REMOTE 700                         } SG-4 at remote control and initialization
120 CLEAR 700                          }
130 ON INTR 7 GOSUB 650                } Interrupt with SRQ
140 ENABLE INTR 7;8                    }
150 !
160 !  PROG. SG4
170 !
180 !
190 DIM G$[2000]                       Reserve storage area
200 !
210 G$=""                              210: G$ initialization     220: X value (f START)
220 X=0
230 ! Attenuation function of the
    low-pass (Butterworth filt-
    er, order 5)
240 A=-(20*LGT(SQR((.1+.01*X)^10       Attenuation function (-sign due to scale calibra-
    +1)))                              tion),
250 Y=3*(A+80)
260 Y=INT(Y)                           } Normalization to 80 dB scale
270 IF Y<10 THEN 330                   }
280 IF Y<100 THEN 310                  }
290 Y$=VAL$(Y)                         } Form 3 position Y string
300 GOTO 340                           }
310 Y$="0"&VAL$(Y)                     }
320 GOTO 340                           }
330 Y$="00"&VAL$(Y)                    }
340 G$=G$&Y$
350 X=X+1                              } Configure G$
360 IF X=510 THEN 380                  } Run through X values from 0 to 510
370 GOTO 240                           }
380 !
390 !
400 !
410 ! Preconditions
420 OUTPUT 700 ;"T1,B0,K0,S1,"
430 TRIGGER 700                        Trigger mode, command Store A—►B sent with
440 !                                  preconditions
450 !
460 ! G0 u. G1-String                  }
470 OUTPUT 700 ;"G0"&G$&","&"G1"       } Send output strings G0 and G1 to SG-4
    &G$&","                            }
480 TRIGGER 700                        }
490 !
500 ! B-Curve
510 OUTPUT 700 ;"B1,"                  Call-up B curve
520 TRIGGER 700
530 !
540 DISP " B - Curve !"
550 GOTO 550 ! END
560                                    }
 .                                     }
 .                                     } Use interrupt program according to para. 3.10.4.1
 .                                     }
 .                                     }
 .                                     }
```

3.10.4.6 Data output (D)

The curves displayed on the CRT screen may be read-out in normalized form (y_{min} or y_{max} value) by use of the programming word "D...". As an example a part of a curve (100 points of the curve) shall be transferred to the computer, starting at a preassigned frequency value (x = 155). The values are distributed in a C string and, if necessary, can also be stored on magnetic tape in a cassette.

```
 10 DISP "PROG. EXAMPLE SG-4"
 20 !
 30 RESET 7
 40 REMOTE 701                          } SPM-19 at remote control and initialization
 50 CLEAR 701
 60 !
 70 ! SETUP OF THE SPM
 80 !
 90 OUTPUT 701 ;"H10000000.0,W00        }
    010000.0,R060,S55,"                 } SPM-19 set-up: sweep time, amongst others: 3 s (S55)
100 TRIGGER 701                         }
110 !
120 REMOTE 700                          } SG-4 at remote control and initialization
130 CLEAR 700
140 ON INTR 7 GOSUB 470                 } Interrupt with SRQ
150 ENABLE INTR 7;8                     }
160 !
170 !  PROG. SG - 4
180 !
190 !
200 ! Display sweep signal
210 !
220 OUTPUT 700 ;"T0,N1,"                } Trace swept curve
230 TRIGGER 700                         }
240 WAIT 6000                           } Wait for sweep time to elapse (2 x 3 s)
250 !
260 ! Reading the Y-values from
    address 155 (100 values)
270 !
280 !
290 !
300 DIM C$[2046]                          Reserve storage area C$
310 !
320 OUTPUT 700 ;"T1,"
330 TRIGGER 700
340 OUTPUT 700 ,"DAMAX155100,"            Select max. value of swept curve etc.
350 TRIGGER 700                         }
360 WAIT 10                             }
370 S=SPOLL(700)                        } Interrogate the triggers and status bit "BUSY"
380 IF BIT(S,4)=1 THEN 360              }
390 !
400 ENTER 700 USING "%,%K" ; C$           Load computer with SG-4 output string
410 !
420 DISP " Curve in C$ "
430 GOTO 430 END
440                                     }
  .                                     }
  .                                     }
  .                                     } Use interrupt program according to para. 3.10.4.1
  .                                     }
  .                                     }
```

3.10.5 PROGRAMMING WORDS

INTERFACE MODE	XX						,
Service Request after a.c. power on: no		Ø					
Service Request after a.c. power on: yes		1					
Service Request after triggering: no			Ø				
Service Request after triggering: yes			1				
Parity bit: no parity				Ø			
Parity bit: odd parity				1			
Parity bit: even parity				2			
End character in case of ISO 7 bit code: no end character					Ø		
End character in case of ISO 7 bit code: end & data byte					1		
End character in case of ISO 7 bit code: end & LF					2		
End character in case of ISO 7 bit code: LF					3		
End character in case of no ISO 7 bit code: no end character						Ø	
End character in case of no ISO 7 bit code: end & data byte						1	
End character in case of no ISO 7 bit code: end & LF						2	

TRIGGER MODE	T		,
Continuous trigger		Ø	
Single trigger		1	

Preconditions: none

DATA TRANSFER SPM ⟶ SG-4	I	,

Preconditions: T1, KØ, HØ

Post-condition: Serial poll interrogation of status bit "4" (BUSY) see para. 3.10.2.4

The I command is necessary after the setting-up of the Level Meter.

SWEPT CURVE TRACING	N		,
Forwards and backwards		Ø	
forwards only		1	
backwards only		2	

Local operation: continuous "NØ,"

Preconditions: none

Post-condition: after the command has been sent, a programmed waiting time should elapse (dependent on the selected sweep time) before the next command is processed.

VIEW | B | | ,

Current curve A	Ø
Reference curve B	1
A & B	2
A - B	3

Preconditions: none

STORE A→B | S | ,

Preconditions: BØ or B2
KØ

MODE | A | | ,

"AVRG A"	off	Ø
	on	1
"MAX HOLD"	on	2
	off	3

Precondition: HØ

HOLD | H | | ,

Switched off	Ø
Switched on	1

Preconditions: none

SCALE CALIBRATION | E | | ,

Absolute (F_{START} / F_{STOP})	Ø
Relative (F_{CENT} / ΔF)	1

Preconditions: none

X CURSOR VALUE	X				,
Position weighting		10^2	10^1	10^0	

Limits: X cursor switched on: Ø bis 51Ø
X cursor off: > 510

Precondition: KØ

Y CURSOR VALUE	Y				,
Position weighting		10^2	10^1	10^0	

Limits: Y cursor switched on: Ø bis 255
Y cursor switched off: > 255

Precondition: KØ

SOFT KEY DISPLAY	K		,
Switched on		Ø	
Switched off		1	

Preconditions: none

FREQUENCY TRANSFER	F	,

Preconditions: BØ or B2
HØ, KØ
X cursor set-up
J1 "Auto transfer"
T1

Post-condition: corresponds to para. 3.10.2.4

LEVEL TRANSFER	R	,

Preconditions: BØ or B2
HØ, KØ
Y cursor set-up
J1 "Auto transfer"
Current scale range taken over with
T1

Post-condition: corresponds to para. 3.10.2.4

TOLERANCE MASK	L		,
Blanked		Ø	
Traced		1	
Programming		2	

Preconditions: none

TOLERANCE MASK PROGRAMMING	M																,
Mask M1		1															
Mask M2		2															
Position weighting			10^2	10^1	10^0	10^2	10^1	10^0	10^2	10^1	10^0	10^2	10^1	10^0		10^1	10^0	
			x_1			y_1			x_2			y_2			y_n			
			Point 1						Point 2						Point n			

Limit: maximum of n = 32 points for the two masks together

Preconditions: SG-4 TØ, KØ
XØ (X cursor "on")
YØ (Y cursor "on")
L2 (mask programming "on")

In case the mask shall be included in the Level Meter's set-up:
SPM-16/-19: memory function "on" [1)]
address (store 100 to 110)

CANCEL TOLERANCE MASK	C		,
Cancel last point of M1		1	
Cancel last point of M2		2	
Cancel all points (M1 and M2)		3	

Preconditions: TØ, KØ, L2

Note: in case the MEM function is switched on in the SPM-16/-19 - address area 100 to 110 was selected - command "C3," cancels the tolerance mask under the relevant address.

1) See remote control directions for SPM-16/-19

WRITE B CURVE	G											
y_{min} value		Ø										
y_{max} value		1										
Position weighting			10^2	10^1	10^0	10^2	10^1	10^0	10^2	...	10^2	10^1	10^0
			x_0			x_1					x_n		

Limits: $n \leq 510$

y values (y_{min}, y_{max}): $0 \leq y \leq 255$

y value > 255 ⟶ y = 255

Preconditions: none

GRAPHIC PLOTTER OPERATION	P		,
Stop plotting (without drawing grid)		Ø	
Start plotting (with grid)		1	
Start plotting (without grid)		2	
Stop plotting (with grid)		3	

Preconditions: T1, K1, H1

Post-condition: according to para. 3.10.2.4

DATA OUTPUT	D											,
Curve A		A										
Curve B		B										
Error message		E										
y_{min} value of curve			M	I	N							
y_{max} value of curve			M	A	X							
Start address (position weighting)						10^2	10^1	10^0				
Number of curve values (position weighting)									10^2	10^1	10^0	

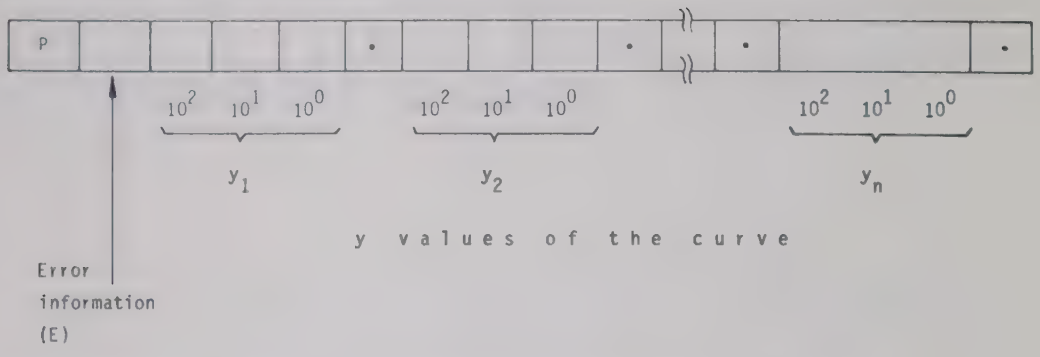
Limits: start address: Ø bis 510

number of curve values: 511 - start address

Preconditions: none

3.10.6. DATA OUTPUT FORMAT

Result after "ENTER" command:



Result after "ENTER" command with data requested by programming word of form "DE"

E					,
	10^3	10^2	10^1	10^0	
No error	Ø	Ø	Ø	Ø	
CAL error	Ø	2	Ø	Ø	
SPM error	Ø	3	Ø	Ø	

3.10.7 PROGRAMMING WORD FOR CONTROLLER MODE

Controller mode		Y Y										,
Service request SRQ for requesting the controller function	no	Ø										
	yes	1										
Talker address of external controller			10^1	10^0								
Second talker address of external controller					10^1	10^0						
Listener address of external controller							10^1	10^0				
Second listener address of external controller									10^1	10^0		

The controller mode is set according to YYØ31313131:

- with a.c. power return (after an a.c. power dropout), if the RAM standby battery is not functioning correctly
- with initialization of the instrument by means of IEC Bus command, IFC. The IFC command causes initialization of the instrument when the CIR strap is in place on the IEC Bus Interface, and when the CLEAR signal of the IEC Bus Interface is switched to the TRAP interrupt. Both conditions must be fulfilled, on principle.
- with initialization of the instrument by means of IEC Bus command DCL or SDC (reset function DC)

4 MEASURING NOTES

4.1 CHECKING SETTLING

If the selected sweep rate is too high for display of the traces, settling problems may occur.

Fig. 4-1 shows the frequency response of a 3.1 kHz bandpass filter, where the forward and backward traces do not coincide; sweep time = 0.3 seconds.

The sweep time should be increased with rocker switch [17] on the Level Meter. On older display units, it was often necessary to select a short sweep time (< 1 second) due to the short persistancy of the screens. In the SG-4, this is not necessary, as the complete trace is stored.

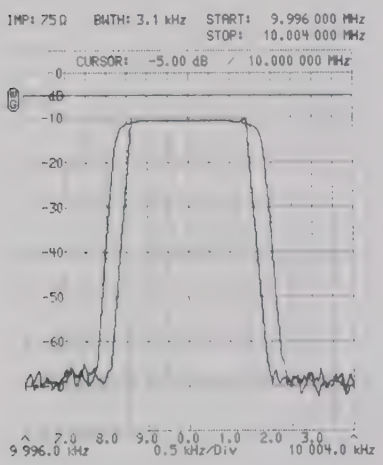


Fig. 4-1 Separate display of forward and backward sweep ("A" mode) with sweep rate set too high

4.2 AUTOMATIC SELECTIVE END-TO-END MEASUREMENT, RECEIVER TRACKING

As an alternative to recording of measured values with the aid of a printer, XY plotter, etc., from the selective Level Meters SPM-16 and SPM-19 in the operating mode "track" - see Section 4.11 of the appropriate operating instructions - display of the measured values on the Display Unit offers decisive advantages. As the results are displayed within a calibrated graticule, which can be modified as required with auxiliary lines and tolerance masks depending on the frequency and dynamic range, evaluation becomes more efficient.

4.2.1 INSTRUMENT SETUP

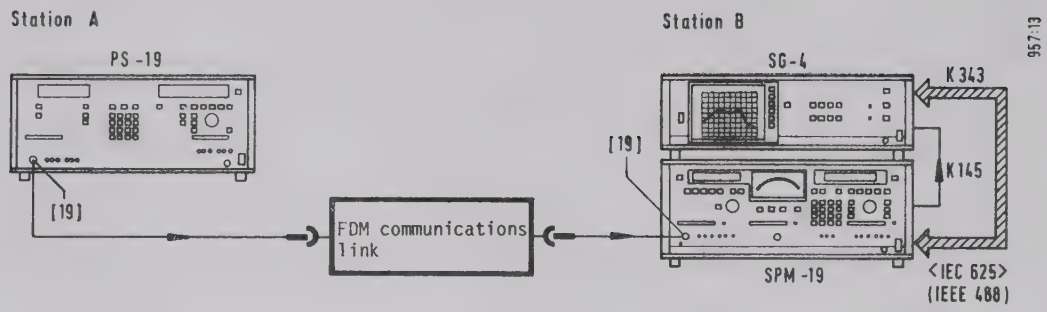


Fig. 4-2 Test configuration for display of frequency response of a FDM communications circuit with the Display Unit (receiver track mode)

For receiver track mode, the instruments are set-up as shown in Fig. 4-2.

Examples for setting

of PS-19

- f_{START} = 1 MHz
- f_{STOP} = 6 MHz
- f_{STEP} = 0.5 MHz
- If required, AUTO BLANK on
- Step time = 3 sec.

of SPM-19

- f_{START} = 1 MHz
- f_{STOP} = 6 MHz + 1 Hz![1)]
- f_{STEP} = 0.5 MHz
- AUTO CAL = off
- AVRG = off
- Step time = 1 sec (< step time of PS-19!)
- Measuring range = 20 dB or 1 dB

Starting the receiver track mode

1. SG-4: - Depress key "A" (LED on)
2. PS-19: - Depress key "AUTO STEP" (LED on)
3. SPM-19: - Depress key "f_{START}"
   - Switch on the TRACK function by depressing the key "STEP" once. (The receiver track function is started with f_{START} (PS) = f_{START} (SPM)).

4.2.2 DISPLAY OF RESULTS

In order to clearly demonstrate track mode with the Display Unit, a frequency range of 1 to 6 MHz was selected (randomly) in the example in Section 4.2.1. This is sampled in steps of 0.5 MHz (f_{STEP}). For measurement of a system actually carrying traffic, the gaps in which selective measurements may be carried out are defined. In this case, track mode is carried out with stored fixed frequencies[1), 2)]. The frequency of the communications circuit, displayed on

---

1) On older Level Meters (SPM-16 up to Series D, SPM-19 up to Series I), the stop frequency must be entered such that f_{STOP} (SPM) > f_{STOP} (PS). If f_{STOP} < f_{START} is selected, f_{STOP} (SPM) < f_{STOP} (PS) applies! In the case of programmed fixed frequencies, f_{STOP} (SPM) must be entered twice in neighboring addresses.

2) See Section "storing fixed frequencies" of the appropriate operating instructions (generator and receiver).

the screen, appears as a series of straight lines, as the level values measured at the discrete frequencies are automatically connected by line segments; see Fig. 4-3a. If measurements are carried out on systems not carrying traffic, the frequency response can be displayed with more accuracy if the number of frequency steps is increased (or if f_{STEP} is reduced). Fig. 4-3b shows the frequency response of the communications circuit with f_{STEP} = 0.1 MHz; (the curve of Fig. 4-3a (f_{STEP} = 0.5 MHz) is also shown for comparison purposes).

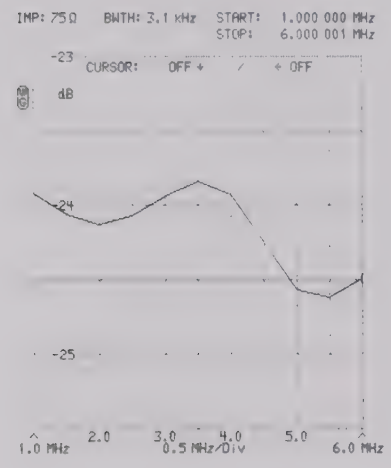


Fig. 4-3a Selective end-to-end measurement ("TRACK" mode) with f_{STEP} = 0.5 MHz

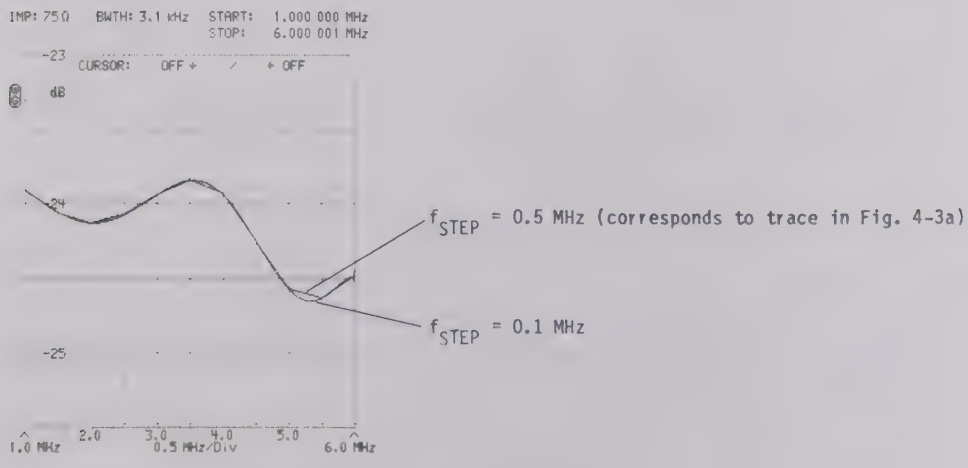


Fig. 4-3b Selective end-to-end measurement ("TRACK" mode) with f_{STEP} = 0.1 MHz

4.3 SPECTRUM ANALYSIS WITH THE DISPLAY UNIT

The loading of a communications system can be displayed with the Level Meter and the Display Unit, "spectrum analysis". Fig. 4-4 shows, as an example, a satellite system carrying traffic. 2 x 5 service channels (audio frequency telegraphy channels) are visible at the lower frequency end (4 to 12 kHz) of this baseband. For spectral displays of this type, the sweep time should be sufficiently long and the bandwidth should be kept as small as possible.

Fig. 4-4 shows, as an example, a satellite system carrying traffic.

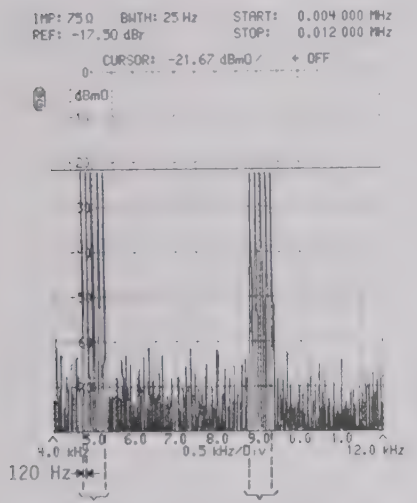

IMP: 75Ω BWTH: 25 Hz START: 0.004 000 MHz
REF: -17.50 dBr STOP: 0.012 000 MHz
CURSOR: -21.67 dBmO ◇ OFF
dBmO
4.0 kHz 5.0 6.0 7.0 8.0 9.0 0.0 1.0 12.0 kHz
0.5 kHz/Div
120 Hz
5 audio frequency telegraphy channels (carrying traffic)
5 audio frequency telegraphy channels (carrying traffic)

Fig. 4-4 Panoramic reception with the SG-4 (satellite transmission system: voice frequency telegraphy channels)

4.4 DRIFT MEASUREMENTS WITH THE SG-4

4.4.1 FREQUENCY DRIFT MEASUREMENT WITH THE FUNCTION "MAX-HOLD" (SG-4)

The Display Unit can be used with its "MAX-HOLD" function for checking the frequency stability of an oscillator. The test configuration is as shown in Fig. 4-5.

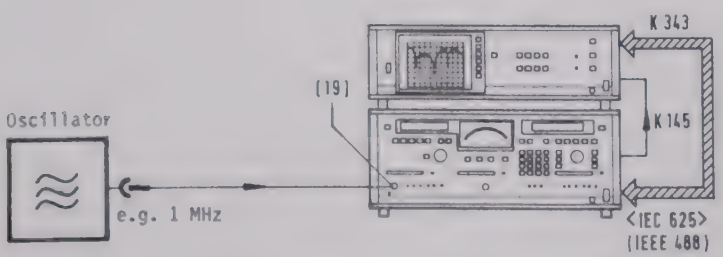


Fig. 4-5 Connection of an oscillator for drift measurement

Settings on SPM-16/19 (example):

- "f_{CENT}" = 1 MHz
- "Δf" = 1 kHz
- "Bandwidth" = 25 Hz
- "Sweep time" $\geq$ 30 sec.
- "Measuring range" [9] } match to output
  "Scale" [10] } level of oscillator
- Depress key "SWEEP"

Functions on SG-4:

- Depress key "A" (LED on)
- Depress key "MAX-HOLD" [8] (LED on)

Fig. 4-6a shows the frequency drift of the signal being examined after a long observation time. The spectral line which was displayed at the start of the observation time (illustration of active selection filter, see dotted line) has drifted approx. 110 Hz to the left, i.e. to a lower frequency.

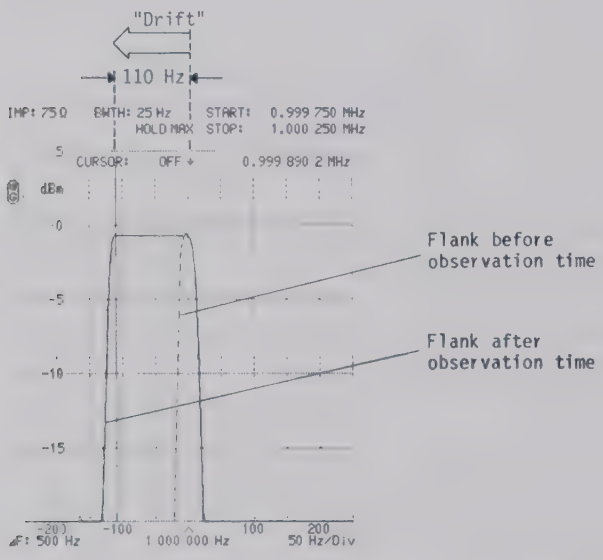


Fig. 4-6a Frequency drift measurement with "MAX-HOLD" function

4.4.2 FREQUENCY DRIFT MEASUREMENT WITH "AFC" FUNCTION (SPM-16/19)

Frequency and level drift measurements can also be detected with the "AFC" function (automatic frequency-control) of the Level Meter and displayed on the screen of the Display Unit (see also Section 4.10 of the operating instructions for the Level Meter).

The test configuration is the same as that shown in Fig. 4-5. As an example, the following describes measurement of a 1 MHz oscillator.

Settings on SPM-16/19 (example):

- "f_{CENT}" = 1 MHz
- "Δf" = 1 kHz
- Match measuring range [9] and scale [10] to output level (1 dB scale)

} Display range for SG-4 (graticule)

- Bandwidth = 400 Hz
- Depress key "f"
- Depress key "MAN" (FINE)
- Tune with knob [14] until the meter indicates approx. full scale deflection

} 1 MHz signal is displayed as a dot

- Depress key "AFC" (LED on)

on SG-4:

- Depress key "A" (LED on)

After a longer observation time (e.g. 30 mins), the drift of the oscillator frequency causes a horizontal line to be displayed on the screen (only frequency drift can be observed); see Figure 4-6b. The length of the line (i.e. the frequency drift) is approx. 150 Hz.

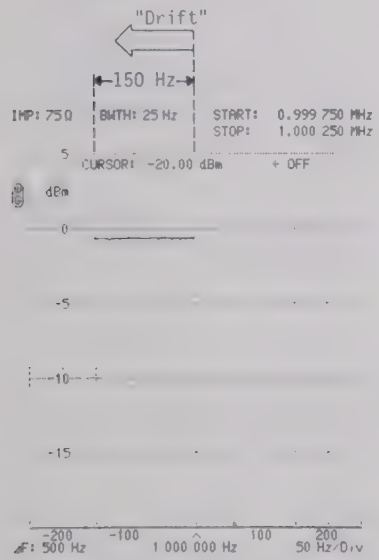


Fig. 4-6b Frequency drift measurement "AFC" function

5 FUNCTIONAL CHECK, MAINTENANCE AND MISCELLANEOUS

5.1 FUNCTIONAL CHECK

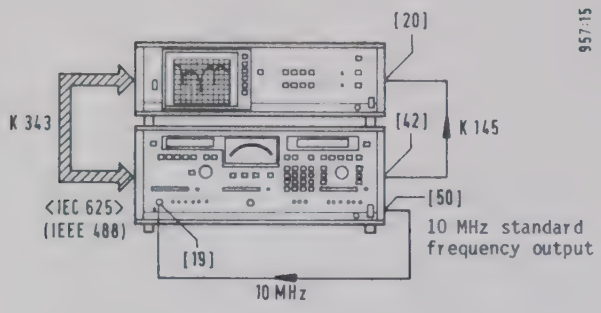


Fig. 5-1 Cable connections for functional check

The functional check is carried out when putting the instrument into service. For execution of this check, connect the cables between the SG-4 and SPM-16/19 as shown in Fig. 5-1 and observe the notes in Section 3.1.6 and 3.1.7. The test is carried out in the sequence specified in Table 5-1, page 5-1 and on the following pages.

SPM-16/19 setup	SG-4 setup	Expected screen display	Remarks
	Actual trace display		
[10]: 80 dB [9]: 0 dB f_{CENT}: 10 MHz Δf: 10 kHz [16]: 3.1 kHz [17]: 3 sec. [3]: "ABS" [13]: "SWEEP"	[3] "A"	Actual trace A (3.1 kHz selectivity curve)	Check whether - record marker visible - Receiver data correctly displayed
	Depress soft key "FREQ SCAL" several times	Actual trace A	- absolute and relative frequency scales alternately displayed
	[10] "STORE A→B"	Actual trace A	LED [10] must blink momentarily
	[3] "B"	Reference trace B	- B coincides with A
[9] + 5 dB	[3] "A & B"	Reference trace B and shifted trace A	- Display: B-SCALE - 5.00 dB
	[3] "A - B"	Difference trace in area -5 dB line	- Display: B-SCALE - 5.00 dB
	Cursor movement		
[9] 0 dB	[3] "A" [4] to the right [4] to the left [11] upwards [11] down	Actual trace A	Check whether - Frequency cursor moves to the right - Frequency cursor moves to the left and can be switched off - Level cursor moves upwards - Level cursor moves downwards and can be switched off
	[4] to 9.996 MHz Depress [5] f_{CENT} [11] to -20 dB Depress [12] REF.L	Actual trace shifted to the right Actual trace is moved upwards	- Frequency scale is updated - Display: REF: -20 dB - SPM-16/19: "ABS-REF" function active
	Averaging, MAX HOLD, HOLD FUNCTION		
[10]: 20 dB	[11] to -20 dB Depress [12]: "REF L" twice Depress [9] "AVRG A"	Stop band at left of current trace	- Noise band with spikes - REF: -60 dB - Cursor: -20 dB/ 9.992 MHz Wait until several sweep cycles are finished Check whether - noise spikes are suppressed.
	Depress [8] "MAX HOLD"		- AVRG function off - Upper limit of noise band displayed
	Switch off [8] "MAX-HOLD" Switch on [7] "HOLD"		- Noise band frozen

SPM-16/19 setup	SG-4 setup	Expected screen display	Remarks
	T o l e r a n c e m a s k s		
Remove cable from input [19]	Switch off [7] "HOLD" [2] "SCALE MENU" on Depress soft key "PRGM MASK" Depress soft key "CUR→M1" [11] to -15 dB [4] to 9.993 MHz Depress soft key "CUR→M1"	Monitor display as in Fig. 3-8 Monitor display as in Fig. 3-18	First mask point stored Check whether - Straight line displayed
	Depress soft key "CLR→M1"		- Straight line deleted

Table 5-1 Sequence of functional check

5.2 M E S S A G E S D I S P L A Y E D O N T H E S C R E E N (S U M M A R Y)

Screen display	Meaning
TEST (momentary)	During internal test after switching on the instrument
CAL (momentary)	After internal test, during calibration of graticule
IEC/IEEE-BUS?	Error message ● after SG-4 has been switched on and executed testphase Reason: - Cable K 343 not connected - Bad ground contact - Interface board of Level Meter not correctly inserted - Front panel of Level Meter blocked: LED "REMOTE" on (remedy: depress "LOCAL" key)
ADDRESS ?	● Address switch "SC" set to - "OFF" in manual mode - "ON" in remote mode ● System address unknown
SPM ?	● After switching on if - cable K 145 not connected - bad ground contact - Level Meter not switched on

Screen display	Meaning
B SCALE ... dB	If range (rotary switch [9]) of Level Meter) of actual trace was changed with respect to that used for reference trace (in modes "A & B" and "A - B")
B TRACE PARAMETERS DIFFERENT	If the receiver parameters were changed in mode "A & B" or "A - B"
MASK CLEARED	After clearing the tolerance mask with soft keys "CLR M1" and "CLR M2"
MASK MEMORY OVERFLOW	Tolerance mask memory capacity exceeded during programming of several masks.
MASK IN MEM No. ...	After storing the tolerance mask (→MEM) for corresponding setup (Address No.)
UNDEF. !	Error message - After depression of key [10] "STORE A→B" while key "A & B" or "A - B" or "B" is on. - If cursor transfer key [5] or [12] was depressed with cursor switched off (OFF). - If key "MAX-HOLD" or "AVRG" was depressed during "HOLD" function.

Table 5-2 Error messages and notes on the screen

5.3 MAINTENANCE AND MISCELLANEOUS

If correctly handled, the Display Unit requires no special maintenance. The closed case protects the electronic circuits even during transport. However, we recommend the use of the corresponding Protective Covers SD-3 in order to protect the screen and controls on the front panel and the sockets on the rear against splashwater, dust, and mechanical damage. The instrument can also be carried with the handle of the Protective Cover.

5.3.1 MECHANICAL CONSTRUCTION

Caution: Before opening the instrument, disconnect the mains plug!
The instrument must always be switched off when removing or inserting modules.

The case dimensions correspond with DIN Standard 41 494 and American Standard ASA C 83.9. The instrument can therefore be mounted in 19" racks. The top and bottom covers and the side walls are made of robust cast aluminium.

For servicing purposes, the top cover can be removed after loosening the 6 socket head cap screws (wrench in accessory compartment on rear of instrument). The complete chassis including the front panel and rear wall can then be lifted out of the case.

It should be noted that the chassis is connected to the power supply unit on the right wall of the case by two removable plug connectors. Fig. 5-2 shows the various modules after removal of the top cover.

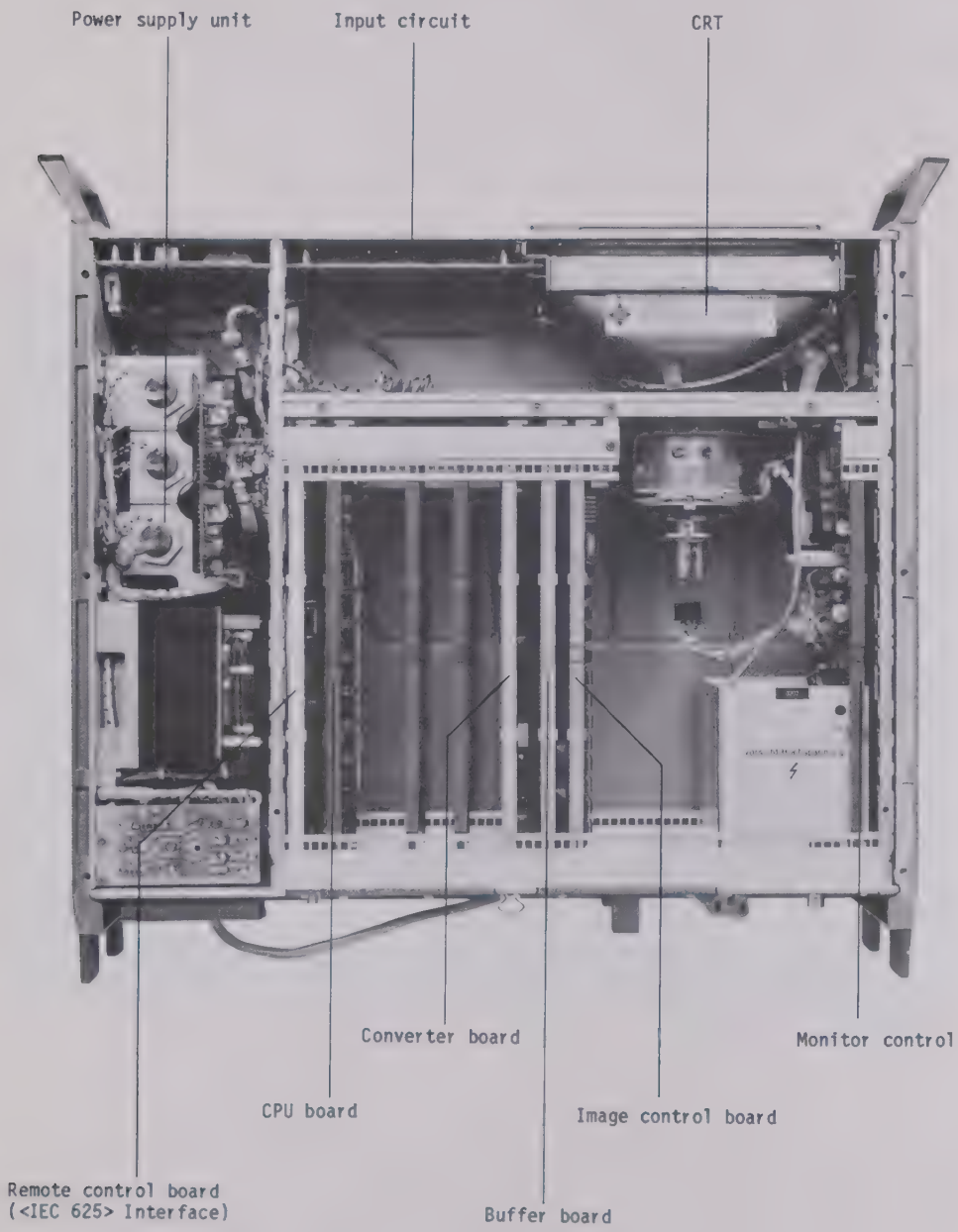


Fig. 5-2 Module arrangement after removal of cover (top view)

5.3.2 REMOTE CONTROL BOARD <IEC 625> INTERFACE

The address switches for the instrument address are located on the rear of the SG-4. It is therefore not necessary to remove the control board for address setting. If the SG-4 is controlled by a computer, the DIO line, on which the SG-4 transfers a status bit, must be defined for parallel polling. The DIO line is set with the parallel poll switch, which is located within the instrument on the remote control board. To remove the remote control board, loosen the two screws on the rear of the unit; the board can then be pulled out. (The chassis does not need to be removed).

Fig. 5-3 shows part of the remote control board with the parallel poll switch.

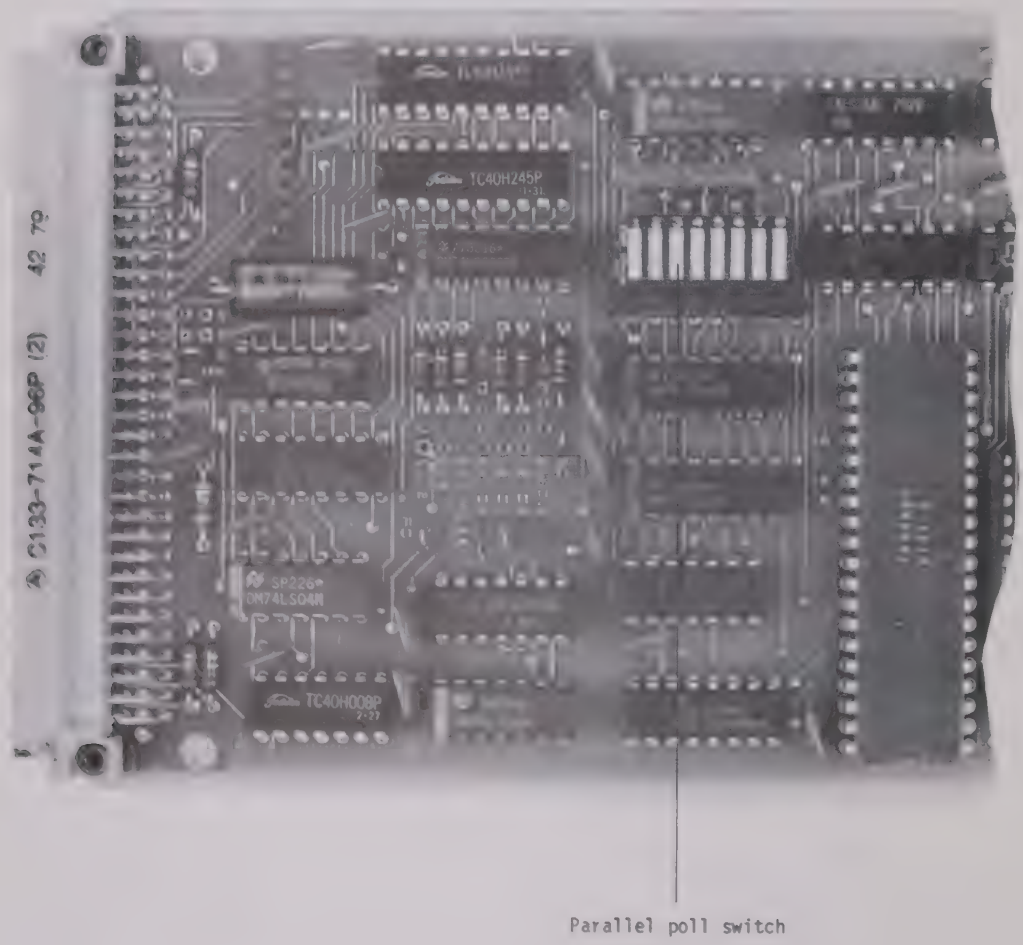


Fig. 5-3 Remote control board with parallel poll switch for definition of the data line for the status bit during parallel polling

5.3.3 BATTERIES FOR DATA RETENTION

The built-in batteries ensure that the front panel setup and the programmed tolerance masks or the stored trace "B" are maintained if the mains voltage is interrupted for a short time or switched off. The data are retained for at least 30 days without intermediate charging of the battery. The batteries are trickle-charged whenever the instrument is on.

The 3 cells are mounted in the power supply unit on the right wall of the instrument. After removal of the chassis (see 5.3.1), the cells (Ni-Cd cells Type "LADY") are accessible. The cells can be replaced after removing the metal retainer - push the retainer up with a screwdriver until the spring disengages from the hole in the printed circuit board.

5.3.4 BOOTSTRAPPING

After the microprocessor circuit has been separated from the power supply voltage (when batteries are changed or CPU cards are exchanged etc.) the Display Unit must be bootstrapped for initialization.

- "LOCAL" depress push button and simultaneously switch on instrument.

Perhaps stored tolerance masks or the reference curves are deleted as a result. If the initialization procedure is carried out without the connections to the, Level Meter (K 145 and K 343) then the CRT screen displays "SPM ?" as explained in section 3.1.7.1.

Note: After the SG-4 has been switched on (Level Meter connected and switched on), under certain conditions (battery partially discharged) the front panel controls might be non-functional; then the SG-4 is "locked-out". The lock-out may be de-activated by the initializing of the SG-4.

Display Unit SG-4

Operating instructions

V I D E O S C R E E N

for displaying

- the measuring curves (selectable under [3] in the calibrated internal graticule; the actual curve is intensified to show the difference. Variable measuring lines (Cursors), as well as tolerance mask are displayed at choice. Relevant receiver parameters are displayed alphanumerically.
- the scale menus (monitor pictures 1 and 2) (for explaining the soft keys).
- of information text for instrument settings, for operating status, or with erroneous operation.

SCALE MENU [2]

After key has been depressed (LED on), the soft key functions are available for activation.

MEASURING CURVE DISPLAY [3]

Selectable according to each key (LED on) respectively

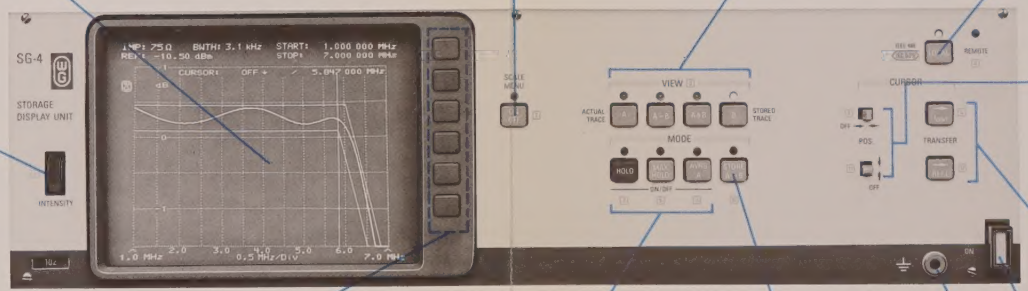
- A, actual measuring curve
- A-B, actual measuring curve minus reference curve
- A&B, simultaneous display of actual curve and reference curve (curve A is displayed with greater intensity).
- B, stored reference curve: remains even after a.c. power is switched off.

REMOTE CONTROL [6]

- All key functions are controllable via computer (LED REMOTE on); front panel controls are locked-out.
- Changeover to manual operating by LOCAL key (green LED on)

INTENSITY CONTROL [1]

For setting the video screen intensity and the contrast of the measuring and reference curves.



VARIABLE MEASURING LINES (CURSOR)

FREQUENCY CURSOR [4]

The paddle switch being moved left or right causes the frequency line to be shifted over the complete internal graticule. The actual frequency value is displayed on the video screen. In position "OFF", the frequency cursor is switched off.

LEVEL CURSOR [11]

The paddle switch being moved left or right causes the frequency line to be shifted over the complete internal graticule. The actual level value is displayed on the video screen. In position "OFF", the level cursor is switched off.

CONNECTIONS ON BACK PANEL

- A.C. power with voltage selector switch
- <IEC 625>/IEEE 488 connection to SPM-16/19, for controlling the graphic plotter (HP 7470 A), or with remote control via computer
- Display Unit connector (X, Y signals)
- Video output (BNC)

CURSOR TRANSFER

After "f_{CENT}" [5] is depressed, the displayed frequency value is transferred so as to be the new center frequency of the SPM-16/19.

After "REF.L" [12] is depressed, the displayed level value is applied as reference level in the SPM-16/19.

S O F T K E Y F U N C T I O N S

Key functions are displayed on the video screen when the scale menu (key [2] ON) is depressed. Abbreviated functions are displayed at the height of the corresponding soft key.

Scale menu 1

- FREQ SCALE: frequency scale lettering in absolute calibration (F_{START}/F_{STOP}) or relative calibration ($F_{CENT}/\Delta F$)
- GRPH PLOT: graphic plotter recording (RUN) or (STOP)
- RAST: measuring curve with (ON) or without (OFF) background display
- TOL MASK: programmed tolerance mask displayed (ON) or blanked out (OFF).
- PRGM MASK: switches in tolerance mask programming (Masks M1, M2 comprising 32 points)
- RET: return to measuring curve display

Scale menu 2

- CUR M1: storage of cursor interrupt point, M1 tolerance limit
- CUR M2: storage of cursor interrupt point, M1 tolerance limit
- CLR M1: clear the last entered M1 mask point
- CLR M2: clear the last entered M2 mask point
- MEM: store the tolerance mask under address of the related setup (address area 100 to 110 of the SPM-16/19)
- RET: return to scale menu 1.

SPECIAL FUNCTIONS

HOLD [7]

After key has been depressed (LED blinks) the entire screen information is frozen in place; e.g. switched on for plotting curve.

MAX. HOLD [8]

After key has been depressed (LED on) the curve is refreshed at the position where the actual level value is larger than the already traced value.

AVRG A [9]

After key has been depressed (LED on) noisy curve sections are smoothened by digital display averaging.

STORE A→B [10]

Key for the storage of actual curve A as reference curve in the B store. The red LED lighting is the signal that storing is taking place.

A.C. POWER SWITCH

When push button is pressed in, the SG-4 is switched on. After switch on, the self-test, TEST, and a calibration, CAL, are performed.

GROUND TERMINAL

Connected to enclosure and protective earth conductor of power cord.

0.25.8.83 3095

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